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Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

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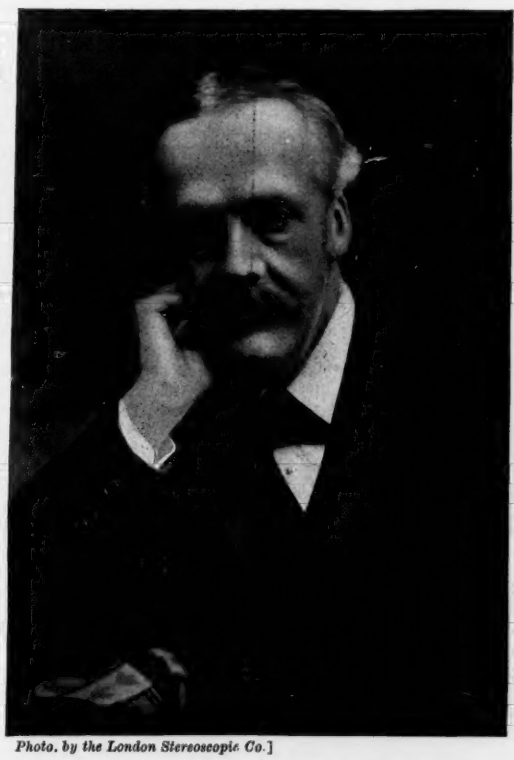
THE BRITISH ASSOCIATION.

Presidential Address.

Sectional Addresses. .

ONE of the most interesting and most largely attended meetings of the British Association during recent years began its sessions at Cambridge on Wednesday, the 17th of August. The unique position which Cambridge occupies in the history of science, and the great part which she has played in its development, joined to the attractions which an ancient University always extends to visitors, drew a representative gathering not only of British men of science, but of distinguished foreign physicists, zoologists, biologists, and economists. The Presidential address of the Right Hon. A. J. Balfour was delivered on Wednesday evening, and was heard by an audience that was as brilliant as it was crowded.

THE PRESIDENT, the Right Hon. A. J. Balfour, said that the meetings of the Association had been held for the most part in crowded centres of population where the surroundings never permitted them to forget, were such forgetfulness in any case possible, how close was the tie that bound modern science to modern industry, and that was no doubt as it should be; the interdependence of theory and practice could not be ignored without inflicting injury on both, and he was but a poor friend to either who undervalued their mutual co-operation. Yet, after all, since the British Association existed for the advancement of science, it was well that now and again the members should choose their place of gathering in some spot where science, rather than its applications, knowledge not utility, were the ends to which research was primarily directed. If that were the case, surely no happier selection could have been made than the quiet courts of that ancient university—for there, if anywhere, they trod the classic ground of physical discovery. Unless he was led astray by too partial an affection for the old university, there was nowhere to be found in any corner of the world a spot with which had been connected either their training in youth, or by the labours of their mature years, so many men eminent as the originators of new and fruitful physical conceptions. He said nothing of Bacon nor of Darwin, the Copernicus of biology, for his subject was not the contributions of Cambridge to the general growth of scientific knowledge. He was concerned rather with the illustrious physicists who had learned or taught within a few hundred yards of that spot —a line stretching from Newton in the Seventeenth Century, through Cavendish in the Eighteenth, through Young, Stokes, and Maxwell in the Nineteenth, through Kelvin—who embodied an epoch in himself—down to Rayleigh, Larmor, and the scientific school centred in the Cavendish Laboratory, whose physical speculation bade fair to render the closing years of the old century and the opening years of the new as notable as the greatest which had preceded them. What was the task which these physicists had set themselves to accomplish? Whither led their "new and fruitful conceptions?" Physics was often described as the "discovery of the laws connecting phenomena." That was a misleading expression, because the phenomena investigated were things that could not appear to beings so poorly provided with sense perception as ourselves. But apart from the linguistic error, was it not also inaccurate to say that a knowledge of Nature's laws was all we sought when investigating Nature? The physicist sought for something deeper than the laws connecting possible objects of experience. His object was physical reality, which might or might not be capable of direct perception —a reality which was in any case independent of it; a reality which constituted the permanent mechanism of that physical universe with which our empirical connection was so slight and so deceptive. If, then, one of the tasks of science, and more particularly of physics, was to frame a conception of the physical universe in its inner reality, then any attempt



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THE RIGHT HON. A. J. BALFOUR, M.P., President.

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to compare the different modes in which from time to time this intellectual picture has been drawn could not fail to suggest questions of the deepest interest. With those which were purely philosophical the character of the occasion precluded him from dealing; with those that were purely scientific his own incompetence forbade; but there were some questions near enough the dividing line to induce one to consider them.

He would take, therefore, for his point of departure the closing years of the Eighteenth Century, a little more than a hundred years after the publication of Newton's "Principia." If at that period the average man of science had been asked to sketch his general conception of the physical universe he would probably have said that it consisted essentially of various sorts of ponderable matter, scattered in different combinations through space, exhibiting various aspects, but through every metamorphosis obedient to the laws of motion; always keeping its mass unchanged, and exercising at all distances a force of attraction on other material masses, according to a simple law. The late Eighteenth Century physicist might have added the so-called "imponderable" heat to the category of ponderable matter, together with the two "electrical fluids," and the corpuscular emanations supposed to constitute light. In the universe as thus conceived "action at a distance" was the most important form of action, the principle of the conservation of energy was undreamed of, electricity and magnetism played no great part in the whole of things, nor was a diffused ether required to complete the machinery of the universe. Within a few months of the date assigned to the hypothetical physicist came an addition to this general conception of the world designed profoundly to modify it.

A hundred years ago Young opened, or re-opened, the great controversy which finally established the undulatory theory of light, and with it a belief in an interstellar medium of which undulations could be conveyed. But this discovery was much more than the substitution of a theory of light consistent with the facts for one which was not. Here was the first introduction of a new and prodigious constituent—the ether—into the scientific world picture. Unending space was no longer thinly strewn with suns and satellites. It was now filled with a continuous medium. It gave promise of strange developments. It could not be supposed that the ether, if its reality were once admitted, existed only to convey through interstellar space the vibrations of light—the vibrations which happened to stimulate the optic nerve of man. Intended originally to fulfil that function, to that it could never be confined. It conveyed light and radiant heat and electrical waves and Hertzian waves and waves to which the human perception makes no response. But that was not all or nearly all. If we jumped the century from 1804 to 1904 and attempted to give in outline the scientific world picture as it now presented itself to contemporary speculation, we should find not only that it had been greatly modified by new laws and new discoveries, but chiefly by the more and more important part which electricity and the ether occupied in any representation of ultimate physical reality. Electricity in 1700 was no more to the philosophers than the hidden cause of the insignificant phenomena by which amber or glass, when rubbed, attracted small objects brought into their neighbourhood. It was fifty years before its effects were perceived in the thunderstorm; a hundred years before it was detected in the form of a current; one hundred and twenty years before it was connected with magnetism; one hundred and seventy years before it was connected with light and with "ethereal radiation." But to-day there were those, the protagonists of the electric theory of matter, who regarded gross matter as the mere appearance of which electricity was the physical basis. Such theorists thought that the elementary atom was itself but a collection of monads or electrons, which are not electrified matter but electricity itself—that those systems differed in the number and arrangement and relation of their electrons, and that on those differences depended the various qualities of atoms. Finally, that, while in most cases those atomic systems might maintain their equilibrium for periods that seemed almost eternal, yet they were not less obedient to the law of change than the everlasting heavens themselves.

But if gross matter was a grouping of atoms, and atoms were systems of electrical monads, what were these electrical monads? It might be that, as Dr. Larmor had suggested, they were but a modification of the ether—a modification roughly comparable to a twist or a knot in the ether. Whether that were accepted or not, it was certain that these electrical monads could not be considered apart from the ether. Their qualities depended on their interaction with it. Without it an electric theory of matter was impossible. Surely here was the most extraordinary of revolutions. Two centuries ago electricity seemed but a scientific toy. It was now thought by many to constitute the reality of which matter was but the sensible expression. It seemed possible now that it might be the stuff out of which that universe was wholly built.

Nor were the collateral inferences less surprising. It used to be thought that mass was an original property of matter; neither capable of explanation nor requiring it; in its nature essentially unchangeable; suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to and identified with each material fragment. But if the new theories were accepted, those views must be revised. Mass was not only explicable, but explained. So far from being an attribute of matter, it was due to the relation between the electrical monads of which matter was composed and the ether in which they were bathed. So far from being unchangeable, it changed when moving at very high speeds with every change in its velocity. Perhaps, however, the most impressive alteration in the cosmical picture was in its view of the distant suns and their satellites—the stars visibly incandescent and in process of transformation from the nebulæ whence they sprang to the frozen darkness to which they were predestined. What of the invisible multitude of heavenly bodies in which the process had been completed? According to the ordinary view they had reached a state when all possibilities of internal movement were exhausted. At the temperature of interstellar space chemical action and molecular action would be impossible; and the stars and their constituent elements had no source of replenishment of their exhausted energy except by some celestial collision. But this view must be profoundly modified if we accepted the electric theory of matter. We could no longer hold that if the internal energy of a sun were as far as possible converted into heat which could be radiated away, then the sun's whole energy would be exhausted. On the contrary, the amount thus lost would be absolutely insignificant compared with what remained stored up within the separate atoms. The system in its corporate capacity would become bankrupt. The wealth of its individual constituents would remain undiminished. They would be side by side without movement, without affinity, yet each, however inert in external relations, the theatre of violent forces, by the side of which those that shattered a world and revealed it as a flaming new star to the astronomer's telescope were negligible.

In common with all living things, we seemed to be practically concerned with the feebler forces of Nature and with energy in its least powerful manifestations. Chemical affinity and cohesion were, on this theory, no more than the slight residual effects of the internal electrical forces which kept the atom in being. Gravitation, though it were the shaping force that concentrated nebulæ into suns and satellites, was trifling compared with the attractions and repulsions between electrically-charged bodies; and those again sank into insignificance beside the attractions and repulsions between the electrical monads themselves. The irregular molecular movements which constituted heat, on which the very possibility of organic life seemed to hang, could not rival the prodigious energy stored within the molecules themselves. Yet this prodigious mechanism seemed outside the range of our immediate interests. We lived merely on its fringe. It had no promise of utilitarian value; we could not harness it to our trains. Yet not less did it stir the imagination. Its marvels were greater than those which in the starry heavens had from time immemorial moved the worship and wonder of mankind.

The President went on to comment on the acute intellectual gratification which the theory awakened, a satisfaction almost æsthetic in its intensity and quality. It was, he said, a sentiment possibly derived from an instinct, not lightly to be ignored, in favour of the belief that the material world should be a modification of a single medium rather than a composite structure. These obscure intimations about the nature of reality deserved, he thought, more attention than had yet been given to them. That they existed was certain. The difficulty that arose was when experience apparently said one thing and scientific instinct persisted in saying another. That these new views of matter diverged violently from those suggested by ordinary observation was plain enough. No scientific educa-

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tion was likely to make us in our unreflective moments regard the solid earth on which we stood, or the organised bodies with which our terrestrial fate was so closely bound up, as consisting only of electric monads. Not less plain was it that an almost equal divergence was to be formed between these new theories and that modification of the "commonsense view of matter" with which science had been in the main content to work. What was this modification of common sense? It was roughly indicated by an old philosophic deduction drawn between what were called the "primary" and "secondary" qualities of matter. The primary qualities, such as shape and mass, were supposed to possess an existence quite independent of the observer. The secondary qualities, such as warmth and colour, were supposed to have no such independent existence, being no more than the resultants due to the action of the primary qualities on our organs of sense-perception. And there, no doubt, common sense and theory parted company. Such was the theory on which science had in the main proceeded. It was with matter thus conceived that Newton experimented. To it he applied his laws of motion; of it he predicted universal gravitation.

Nor was the case greatly altered when science became as much preoccupied with the movements of molecules as it was with that of planets. For molecules and atoms were at least pieces of matter, possessed of those "primary" qualities supposed to be characteristic of all matter. But the electric theory carried us into a new region altogether. It was not content to account for the secondary qualities by the primary; or the behaviour of matter in atoms. It analysed matter whether molar or molecular into something that was not matter at all. The atom was now no more than the relatively vast theatre in which the electric monads performed their evolutions; while the monads themselves were not regarded as units of matter, but as units of electricity. So that matter was not merely explained, but was explained away. The point to which he desired to call attention was not to be sought in the divergence between matter as thus conceived and matter as the ordinary man supposed himself to know it, but to the fact that the first of those two quite inconsistent views was wholly based on the second. That was surely something of a paradox. We claimed to found all our scientific opinions on experience, and the experience of the universe was our sense-perception of the universe; yet the conclusions which thus professed to be founded on experience were to all appearance fundamentally opposed to it. Our knowledge of reality was based on illusion. The very conceptions we used in describing it to others, or in thinking of it ourselves, were abstracted from anthropomorphite fancies which science forbade us to believe and Nature compelled us to employ. An added emphasis was given to these reflections by a train of thought that had long interested him, though he acknowledged that it had never seemed to have interested anyone else.

Sense-perceptions supplied the premises from which we drew all our knowledge of the physical world. From them we learned that there was a physical world. But in order of causation they were effects due to the constitution of our organs of sense. What we saw depended not merely on what there was to be seen, but on our eyes. What we heard depended not merely on what there was to be heard, but on our ears. Now eyes and ears had been evolved by the slow processes of natural selection. And what was true of sense-perception was also true of the intellectual powers which enabled us to erect on the frail and narrow platform that sense-perception provided the proud fabric of the sciences. But natural selection worked only through utility. Our powers of sense-perception and calculation were worked out ages before they were effectively employed in searching out the secrets of physical reality. Natural selection possessed no power of prevision. Our organs of sense-perception were not given us for purposes of research, nor was it to aid us in meting out the heavens or dividing the atom; but our powers of calculation and analysis were evolved from the rudimentary instinct of the animal. It was presumably due to this that the beliefs of all mankind about the material in which it dwells were not only imperfect, but fundamentally wrong. It might seem singular to say that down to, say, five years ago our race had without exception lived and died in a world of illusion, and that its illusions were not about things transcendental or divine, but about what it said and handled, "the plain matters of fact," among which commonsense daily moved with its most confident step and its most self-satisfied smile. And that was either because too direct a vision of physical reality was a hindrance in the struggle for existence or else because with so imperfect a material as living tissue it was impossible to arrive at right vision.

If that conclusion were accepted its consequences extended to other organs of knowledge besides those of perception. Not merely the senses but the intellect must be judged by it. Considerations like these did undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which was built out of materials provided by natural science alone. Extend the boundaries of knowledge as far as you pleased; draw the picture of the universe as you would; reduce its infinite variety to the all-pervading ether; trace its evolution to the point of the development of the race and the birth of the scientific handful of men who looked round on the world, and, seeing, judged it and knew it for what it was—perform all these things, and though you might indeed have attained to science, in no wise would you have attained to a self-sufficing system of beliefs. One thing at least would remain of which this long-drawn suspense of causes and effects gave no satisfying explanation; and that was knowledge itself. In conclusion, the President asked the forgiveness of his audience if he had overstepped the ample boundaries within which the searchers into Nature carried on their labours. His first desire had been to rouse in those who, like himself, were no specialists in physics the same absorbing interest in what he felt to be the most far-reaching speculation about the physical universe that had ever claimed support; and if in doing so he had been tempted to show that the farther such speculations were carried the more needful it was to complete our scheme of thought by considerations not drawn from his mere examination of the inanimate world, even those who least agreed might perhaps be prepared to pardon.

Section A.—Mathematical and Physical Science.

PROFESSOR HORACE LAMB, M.A., LL.D., F.R.S., was born in 1849; was Second Wrangler at Cambridge in 1872; Fellow and Assistant Tutor of Trinity, afterwards Professor of Mathematics at Adelaide 1876-1885) and at Manchester. He

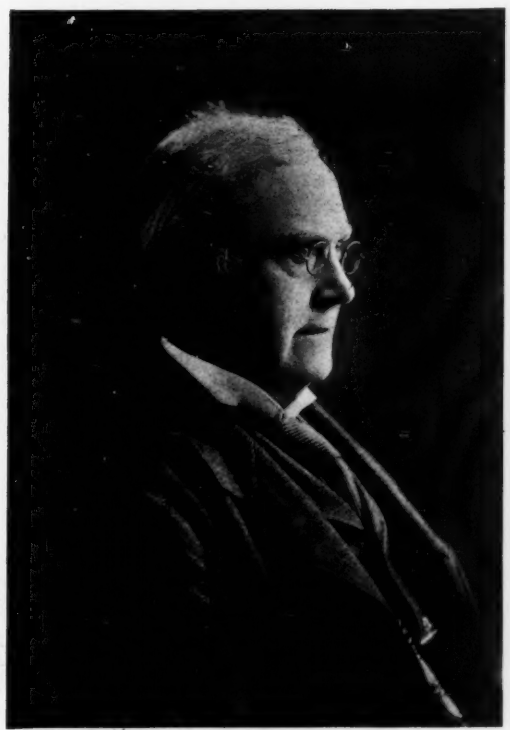

Photo. by Lafayette, Ltd.]

PROF. HORACE LAMB.

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has written on various branches of mathematical physics, and has published a book on Hydrodynamics. He was elected a Fellow of the Royal Society in 1884; Royal Society Medallist, 1902; and is Honorary LL.D. of Glasgow and D.Sc. of Oxford. Professor Lamb is President of the London Mathematical Society.

Professor Horace Lamb's address to the Mathematical and Physical Section was a consideration of the place occupied by the late Sir Gabriel Stokes, who took the presidential chair of the Section when last the British Association met at Cambridge, in the development of Mathematics. The aspect of Stokes' work to which attention was specially directed was its historic or evolutionary relation to the work of his predecessors and followers in that field. The review of this work led to the consideration of the question of the part which abstract conceptions played in the development of science; of the uses, for example, of theories of matter or of electricity, of the atom, of the ether, of the universe. Professor Lamb concluded his paper with a pertinent quotation from the address which Stokes delivered at Cambridge in 1862, and which was one of the shortest ever delivered:—

"In this Section, more perhaps than in any other, we have frequently to deal with subjects of a very abstract character, which is many cases can be mastered only by patient study, at leisure, of what has been written. The question may not unnaturally be asked, If investigations of this kind can best be followed by quiet study in one's own room, what is the use of bringing them forward at a Sectional meeting at all? I believe that good may be done by public mention, in a meeting like the present, of even somewhat abstract investigations; but whether good is thus done, or the audience wearied to no purpose, depends upon the judiciousness of the person by whom the investigation is brought forward."

Sub-Section.—Cosmic Physics.

SIR JOHN ELIOT, K.C.I.E., M.A., F.R.S., was educated at St. John's College, Cambridge.

1869.—Bracketed Second Wrangler. First Smith's Prizeman. Elected Fellow of St. John's College.

November.—Went out to India as Professor of Mathematics in Engineering College, Roorkha.

Photo. by Bourne & Shepherd.]
SIR JOHN ELIOT.

1872.—Transferred to Muir College, Allhabad, also as Professor of Mathematics.

1876.—Transferred to Calcutta as Professor of Physics, Presidency College, and Meteorological Reporter to the Government of Bengal.

1886.—Appointed to officiate as Meteorological Reporter to the Government of India, and in 1888 appointed permanently.

1891.—Also appointed Director-General of Indian Observatories, when the Scientific Observatories at Bombay (magnetic), Madras (astronomical), and Koodookund (solar physics), were placed under the control of the head of the Meteorological Department.

Has written numerous reports and meteorological memoirs; also a "Handbook of Cyclonic Storms in the Bay of Bengal," to serve as a practical book of reference to sailors in that area.

Chief changes in India Meteorological Department during his *régime*:—

(1.) Large extension of storm warning and flood warning work.

(2.) Large extension of area of meteorological observations, chiefly in India, Persia, and the Indian Ocean.

(3.) Large extension of work of collection of meteorological data of the North Indian Ocean and Indian area, and tabulation and publication of daily data with chart.

(4.) Unification of the rainfall; reporting systems and publication of complete annual data for the Indian Empire, &c., &c.

Also took a considerable share in the arrangements for the establishment of a Solar Physics Observatory in India, and for the commencement of a magnetic survey of India.

Sir John Eliot's address to the sub-section of Cosmical Physics dealt chiefly with that department of meteorology which has attracted most attention, and has held forth the greatest possibilities of development during recent years—the theory of weather types. Sir John Eliot's duties as an official meteorologist in India have enabled him to speak with the greatest authority on this subject; and his observations on the regularly recurring weather types of the Indian Ocean are to be regarded as the starting-point of these new methods of investigation. He divided his theme at Cambridge into two parts—(1) A Brief Sketch of the Broad Features of Tropical Meteorology in their Relations to the General Meteorology of the Indo-Oceanic Region; and (2) Illustrations of Abnormal Features of the Meteorology of that Area for the Ten Years ending in 1902. Following on the illustrations which he gave of the uses of seasonal forecasting in India—uses which are identical, in many instances, with the prosperity or the desolation of millions of people—Sir John Eliot urged the establishment of a system of Imperial meteorology. He would coordinate the meteorological system of the British Empire, and establish a central office for the investigation of problems of Imperial meteorology. The area to be dealt with on the Indo-Oceanic area was partially covered by a number of independent meteorological systems, including those of Egypt, East Africa, Central and South Ceylon, Mauritius, the Straits Settlements, and Australia. Large areas were unrepresented, and the departments controlling the systems worked independently of each other. He suggested a combined system, of which the following might be the leading principles:—

(1) The extension of the field of observation by the establishment of observatories in unrepresented areas, and the systematic collection of marine meteorological data for the whole area.

(2) The collection and tabulation of the data necessary to give an adequate view of the larger abnormal features of the meteorology of the whole area.

(3) The direction by some authoritative body of the work of observation, collection, and tabulation of data, in order to secure the use of similar methods for the thorough discussion of the data.

(4) The preparation of the summaries of data required as preliminary to the thorough scientific discussions, and for the information of the officers controlling the work of observation in the contributory areas. The earliest publication of the data should be regarded as essential for use of offices issuing seasonal forecasts.

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(5) The scientific discussion of all the larger abnormal features in any considerable part of the area and their correlation to corresponding or related variations in the remainder of the area by a central office furnished with an adequate staff.

(6) Possibly, sufficient authority on the part of the central office to initiate special observations required for the elucidation of special features for which there are no arrangements in the general work of the various systems.

Section B.—Chemistry.

PROFESSOR SYDNEY YOUNG, D.Sc., F.R.S., is the third son of Mr. Edward Young, of Liverpool, and was born on December 29 at Farnworth, near Widnes. He entered Owens College in 1876, becoming an Associate of the College in 1880, and in the same year was awarded the Scholarship in Chemistry in the B.Sc. final of London University. He proceeded to his D.Sc. degree three years later. At Owens College he

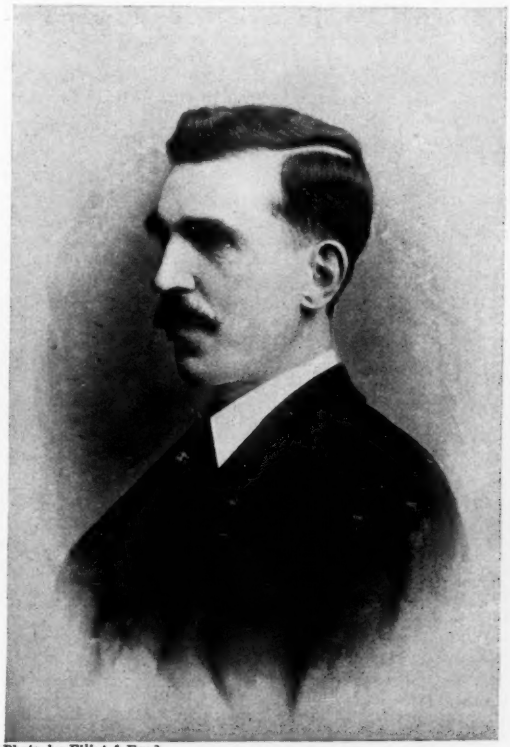

Photo. by Elliot & Fry.]

PROF. SYDNEY YOUNG.

conducted an investigation on "Alcoholic Thiorides," and at the University of Strasburg, where he spent a year in Professor Fittig's laboratory, he carried out researches on "Ethyl-valero-lactone" and other compounds. In 1882 Dr. Young was appointed Lecturer and Demonstrator of Chemistry in University College, Bristol, and during the following five years he was engaged in original work, chiefly in physical chemistry, jointly with Professor Ramsay. On Professor Ramsay's migration to London and occupation of the Professorship of Chemistry at Gower Street, Dr. Young was elected to the Chair of Chemistry at University College, Bristol. He was elected a Fellow of the Royal Society in 1893, and is a Member of the Council of the London Physical and Chemical Societies. He was appointed last October to the Chair of Chemistry in Trinity College, Dublin, in succession to Professor Emerson Reynolds; and this year, as an old Associate of Owens College, Manchester, received the B.Sc. degree of the new Victoria University. His important work on "Fractional Distillation" was published last October.

Professor Sydney Young's Presidential address to the Chemical Section was a review of the state of knowledge of the chemical properties of mixtures, beginning with a summary of Kopp's work during last century on the molecular volumes and boiling points of chemical compounds and ending with the researches of Professor Kuenen. Professor Young defined the investigations of the behaviour of liquids when mixed together as referring to (*a*) their miscibility, infinite, partial, or inappreciable; (*b*) the relative volumes of the mixture and its components; and (*c*) the heat evolved or absorbed; and he went on to outline the modes of investigation applied to these phenomena.

Section C.—Geology.—Earth Sculpture.

MR. AUBREY STRAHAN, F.R.S., M.A., F.G.S., District Geologist on the Geological Survey of England and Wales; born London, April 20, 1852. Educated at Eton and St. John's College, Cambridge.

Publications.—Geological Survey, Memoirs on Chester, Rhyl, Flint, Isle of Purbeck and Weymouth, South Wales Coalfield, and contributions to scientific journals.

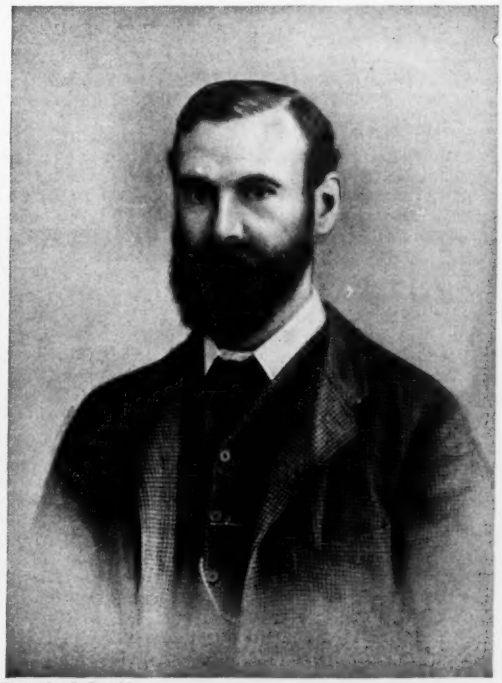

Photo. by C. Brogi]

AUBREY STRAHAN.

Mr. Aubrey Strahan's address to the Geological Section was an attempt to outline the Earth Movements and Earth Sculpture, gradual or cataclysmic, which resulted in the geological formations and the external landscape of the British Isles as now known. With such a history, he concluded, and with the knowledge that mountain ranges had been built in other parts of the world by upheavals of almost recent date, they had more cause to wonder that the internal forces of the globe had left this region for so long, than reason for believing that such phenomena had ceased. Slow changes of level were still occurring; and these might be the outward manifestation of more complicated movements in progress at a depth. The President offered a conjecture as to what appearance the globe would have presented had it not been enveloped with an atmosphere and covered for the most part with water. If these had not existed, the old scars, caused by the belts of crushing and buckling, would have remained, unsoftened by denudation, uncovered by sedimentation. The Earth would then have appeared to the inhabitant of another

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planet as encompassed in a network of fine lines; and one was prompted to ask whether our astronomers distinguished in any other planet markings attributable to this cause.

Section D.—Zoology.

WILLIAM BATESON, M.A., F.R.S., Fellow of St. John's College since 1885. Born Whitby, 1861, son of Rev. W. H. Bateson, D.D., Master of St. John's College; married Beatrice, daughter of late Arthur Durham, Senior Surgeon to Guy's Hospital (1896). Educated Rugby School and St. John's College, Cambridge. Balfour Student 1887-1890.

Publications.—Materials for the Study of Variation, 1894; Mendel's Principles of Heredity, 1902.

Mr. William Bateson, F.R.S., took for his address to the Section of Zoology a subject with which his name has long been conspicuously identified—"The Facts of Heredity and of Variability of Species as Exhibited by the Practical Examination and Experiment of 'Breeding.'" The breeding pen was to the zoologist, said Mr. Bateson, what the test tube was to the chemist, and he insisted that the investigation of the problems of heredity by experimental methods offered the sole chance of progress with the problems of evolution. When Darwin wrote his "Origin of Species," that work which crowned the great period in the study of the phenomena of species, seemed to be, paradoxically enough, the signal for a general halt. The treatise brought the origin of species fairly within the grip of human intelligence for the first time, but, perhaps because it seemed to imply that the specific differences in species were brought about only by the lapse of immense periods of time, it turned men's thoughts to other subjects that were more amenable to the limits of a human life's investigation; and so the wide field from which Darwin drew his store of facts had remained for some forty years unexplored. Mr. Bateson went on to examine the corollaries to the Darwinian hypothesis which other theories had constructed. Among them, for instance, was De Kries' theory of mutations—by which species at a certain period in the long history of their generations become imbued with a tendency to change—and of greater importance to the student of heredity were the laws due to the investigatory genius of Mendel. The general conclusion to which investigation appeared to point was that Nature exercised selective operations no less potent than those which man put into operation in his experiments in breeding. In more scientific language, the true corollary to Virchow's aphorism that every living cell sprang from a living cell, was that "Every variation from type is founded on a pathological accident." In conclusion the President stated the limitations of the knowledge of heredity. "There are others who look to the science of heredity with a loftier aspiration; who ask, Can any of this be used to help those who come after to be better than we are—healthier, wiser, or more worthy? The answer to this question is *No*, almost without qualification. We have no experience of any means by which transmission may be made to deviate from its course; nor from the moment of fertilisation can teaching, or hygiene, or exhortation pick out the particles of evil in that zygote, or put in one particle of good. Education, sanitation, and the rest, are but the giving or withholding of opportunity."

Section E.—Geography.—Mankind and Mountains.

MR. DOUGLAS FRESHFIELD, F.R.G.S., has supplied us with the following particulars: Born 1845. Travelled first in Alps 1854; was constantly taken there by parents and imbibed tastes for mountains early; climbed Mont Blanc 1863, made long journey including many "new" peaks and passes in 1864, recorded in "Thonon t Trent," privately printed journal, now rare. Visited Caucasus after journey in Syria in 1868 (described in "Travels into Central Caucasus and Bashan"); ascended for first time Elboug and Kasbeh, returned to Caucasus in 1887 and 1889, ascending Tetwald and other peaks; crossed Caucasus eleven times by eight different passes—see "The Exploration of the Caucasus," a luxurious book illustrated by Vittorio Sells; visited Sikkim in 1899 and made first tour of Kawgchenjunga penetrating Nepaulese valleys and crossing a pass of over 20,000 feet after the heaviest snowfall ever known in that region (see "Round Kawgchenjunga"). My Alpine tours are recorded in "The Italian Alps," 1875. I was for some years, in succession to Sir Leslie Stephen, editor of the *Alpine Journal*; have been President of the Alpine Club; was for thirteen years an Hon. Secretary of the Royal Geographical Society, and am now Chairman of Committee of the Society of Authors, President of the Society of Geographical Teachers, and Treasurer of the Hellenic Society. I edited two editions of the Royal Geographical Society's "Hints to Travellers" and also two editions of "Murray's Handbook to Switzerland," and have contributed to the Badminton Library and various periodicals. I know, besides, the Alps, Norway, Italy, Corsica, Algeria, Spain; travelled in Greece this spring and climbed Taggetus and Parnassus.

My father was one of the solicitors to the Bank of England. I am a landowner in Sussex. I had a large share in remodelling the publications of the Royal Geographical Society, and have worked for the improvement of maps, ordnance and private, in this country.

Have written articles on historical subjects connected with mountains, "Pass of Hannibal"; and physical, "The Conservative Action of Ice." I received in 1893 one of the gold medals of the Royal Geographical Society and a gold medal at the Paris Exhibition, 1900, for my "Exploration of the Caucasus."

Mr. Douglas Freshfield's address to the Geological Section, "Mankind and Mountains," was highly historical in its survey of the place which mountains occupy in Nature, and their influence, both spiritual and material, on mankind; but it raised several points of topical interest, including the topography and physical peculiarities of the Himalayas; the period of shrinking and advance of the Swiss glaciers with their hypothecated reference to sun-spot periods; and the question of the influence of mountain heights on respiration and physical endurance. The President remarked that the advance to Lhasa ought to throw much light on this subject. The experience of most mountaineers in the last few years had tended to modify the belief that bodily weakness increased more or less regularly with increasing altitude. Mr. White, the Resident in Sikkim, and Mr. Freshfield himself both found on the borders of Tibet that the feelings of discomfort and fatigue which manifested themselves at about 14,600 to 16,000 feet tended to diminish as they climbed to 20,000 or 21,000 feet.

Section F.—Economic Science and Statistics.—Housing the Poor.

PROFESSOR WILLIAM SMART, LL.D., has been kind enough to supply us with the following biographical particulars which he very modestly, but quite wrongly, supposes are "not of much interest."

"When a student I broke down through overwork; and, giving up all hope of a professional career, entered my father's business, where I remained for some 15 years, going through all the stages, from office boy to commercial partner. My firm was one of the Clark's, now incorporated with the great thread 'combine' of J. & P. Coats. The factories were in Glasgow and New Jersey, and so I obtained that knowledge of practical manufacturing under Free Trade and under protective conditions which, as one may imagine, has done me some little service in my last book, *The Return to Protection*.

"It was at my initiative that the Glasgow Municipal Commission on the Housing of the Poor was constituted two years ago, and my presidential address reflects the experience gained thereat.

"I need only add, I think, that the Adam Smith Chair in the University of Glasgow was founded in 1896, and that I am the first occupant of it. I am a Doctor of Philosophy of Glasgow and an LL.D. of St. Andrews."

Professor Smart, addressed the Section on some of the problems of housing the poor, on which, as a member of the Glasgow Municipal Commission, he had been engaged in examining during the last two years. That Commission arose out of the necessity which had presented itself, contingent on the extensive demolition of insanitary and unsuitable dwellings in Glasgow, of housing the poor whom the extensive municipal operations were turning out. It inquired into the causes of overcrowding; the remedies to be adopted in curing and preventing overcrowding; and the important

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problem of the extent to which the municipality was justified in itself building and owning houses for certain of the poorer classes. Professor Smart's address considered mainly the building and owning of houses as a branch of municipal activity, and examined the particular circumstances which

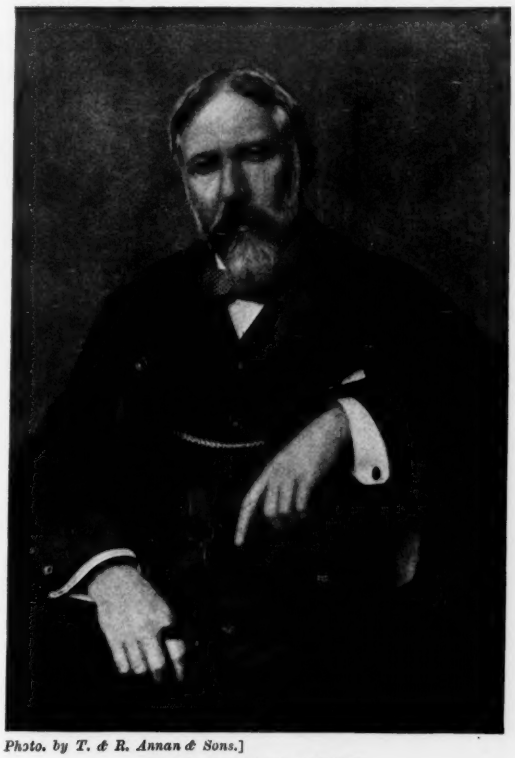

Photo. by T. & R. Annan & Sons.]
PROF. WILLIAM SMART.

might suggest a revision or relaxation of existing principles. Taking the question of principles first, he pointed out that for a municipality to add a new competitive industry to its activities was a serious matter from three points of view. In the first place, house-owning was a business of a special kind and one in which success was not certain. In the second place the municipality entered into direct competition with its own ratepayers, and that in a way quite distinct from the case in which a municipality might provide *all* the water, gas, electricity, or tramway service which its citizens might demand. In the third place, the municipality, by pledging the public credit for a new debt, was probably preventing, immediately, or in the future, the expansion of municipal activity in other directions. These considerations were not decisive against municipal housing, which in some respects was as necessary for the protection and encouragement of the community as the provision of gas or water. For example, a sanitary and comfortable house among quiet neighbours was a direct condition of the efficiency of labour and was quite definitely one of the factors of wage-earning. In other words, a good house, as compared with lodging in a slum, brought with it the possibility of paying for it. The point which especially suggested municipal house-owning was that municipal control over certain classes of houses was necessary in wage-earners' interests. But while the attractiveness of a clean city, to be by these means secured, was one thing, the attractiveness of low rents, which to the poor man's mind was an equally large consideration, was quite another. Was a municipality, in its desire to provide a clean city, to provide also low rents at the expense of the general ratepayer? Professor Smart drew attention at this point to the two propositions usually made on this head: the first, that there was a class which could not afford to pay the higher rent; and the second, that that was a valid reason for the municipality providing them with a lower one. With regard to some people alleged to be unable to pay the higher rent, he again urged that the improvement in their surroundings would make them better wage-earners; with regard to other people, to whom this view could not be held to apply, a municipality which propped them up by giving them lodgings at less than the market rate was supporting the employer in lowering the minimum wage, and was aiding in the undesirable object of attracting more and more unskilled labour, and hopeless, helpless people into the towns. These, then, were the general arguments against municipal building on a large scale, or, as one might say, "on principle." There remained the special circumstances in which a Corporation like Glasgow was justified in building municipal dwelling-houses or lodging-houses. The first case was that in which the Corporation, in order to benefit the city as a whole, was pulling down insanitary or crowded areas, and dispossessing working people of their homes; and the second case was that in which, in order to fulfil modern hygienic requirements, a kind of house was being made necessary by municipal regulations, which could not be let at the old and cheaper rents. The chief thing that a municipality had now to do was to see that the old problems of insanitary and overcrowded houses, which its own inaction had allowed to come into existence, should not recur.

Section G.—Engineering.—Discovery and Invention.

THE HON. CHARLES PARSONS, D.Sc., F.R.S., fourth son of the third Earl of Rosse. Educated—Private Tuition, St. John's College, Cambridge. Scholar, 1873. Eleventh Wrangler, 1876. Elected F.R.S., 1898. Rowed in L.U.B.C 1st Boat and

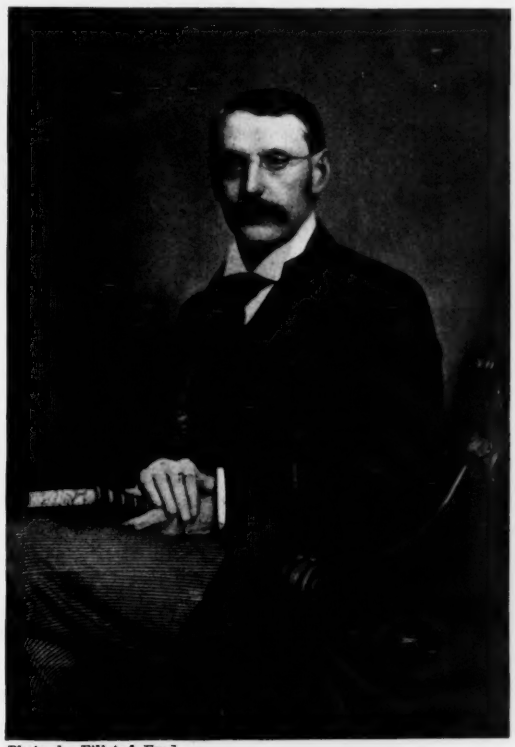

Photo. by Elliot & Fry.]
THE HON. CHARLES PARSONS.

won the College Pairs, 1876. Is proprietor of the engineering works, C. A. Parsons and Co., and Managing Director of the Parsons Marine Steam Turbine Company. He has developed the steam turbine and made it suitable for the generation of electricity and the propulsion of war and mercantile vessels.

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In addressing the Engineering Section on the subject of "Invention," the Hon. Charles Parsons considered the subject in its evolutionary aspect, not as a phenomenon suddenly arising out of some happy stroke of fortune, but as the consummation of the successive labours of a number of workers. From this point of view invention was discovery *plus* development. Generally what was usually called an invention was the work of many individuals, each one adding something to the work of his predecessors, each one suggesting something to overcome some difficulty, trying many things, testing them when possible, rejecting the failures, retaining the best, and by a process of gradual selection arriving at the best method of accomplishing the end in view. For example, the first true internal-combustion engine was the cannon. In 1680 Huggens, and ten years later Papin, tried to use gunpowder as a means of obtaining power by exploding it in a large vessel with escape valves. That was a mistake due to ignorance of thermo-dynamic laws, which would have taught them that the best results would be obtained by exploding under pressure. A century later Street tried to use the vapour of turpentine as an explosive mixture, but his machine failed from bad construction, and Brown, a generation after that, tried Huggens' residual vacuum method and failed. Then came Wright in 1833 with a good gas engine, Barnett—who improved on this design—Bansanti, and Matencci each adding something or subtracting something, till Lenoir in 1866 made the first real and practicable engine. From the consideration of the invention the President passed on to the inventor, his difficulties and the obstacles placed in his way by patent laws, and the small reward for his services compared with the benefits he conferred on his fellows. In the course of his address, the President mentioned two inventions, the undertaking of which would be of great service to mankind, but the practical rewards of which to the individual inventor were so small and so difficult to secure adequately to him that they could hardly be undertaken by private effort. One was the problem of aerial navigation, which could only be successfully solved by an organised and adequately trained body of engineers, and the expenditure of a large sum of money. The other was the exploration of the lower depths of the earth—the deepest borings or shafts in which were at present little more than a mile. The President described a hypothetical method of sinking a shaft to great depths, and offered an interesting estimate of the cost. For £500,000 a shaft two miles in depth could be sunk in ten years; for £1,100,000 a shaft of four miles could be sunk in twenty-five years; and so on. A shaft twelve miles in depth could be sunk in 85 years, and would cost £5,000,000. The temperature of the rock at that depth would be, he estimated, 272 degrees Centigrade.

Section H.—Anthropology.—The Pitt Rivers Collection.

MR. HENRY BALFOUR, M.A., was born in 1863. Educated at Charterhouse School. Entered Oxford University in 1881 as a commoner of Trinity College. After taking degree in the Honour School of Comparative Anatomy, acted under Professor H. N. Moseley as Assistant Curator of the Pitt Rivers Ethnological Collection (presented to the University in 1884). After Professor Moseley's death, became Curator of the Pitt Rivers Museum, which had developed considerably. Elected a member of the Council of the Anthropological Institute of Great Britain in 1891, and its President in 1903 and again in 1904. Elected in 1903 to a Research Fellowship at Exeter College, Oxford. Corresponding member of the Anthropological Societies of Paris, Rome and Florence. President of the Oxford Fencing Club.

The address of Mr. Henry Balfour to the Anthropological Section was in the main a description of the ethnographical collection of Colonel Lane Fox, which is better known as the Pitt Rivers collection, from the name which Colonel Lane Fox took in 1880. The President's avowed object in considering this subject was first to bear witness to the very great importance of General Pitt Rivers' contribution to the scientific study of mankind in general; and to defend the system of arrangement which has been adopted in respect of his ethnographical collection. Its collector based his first inquiries on the theory that the weapons which man used were

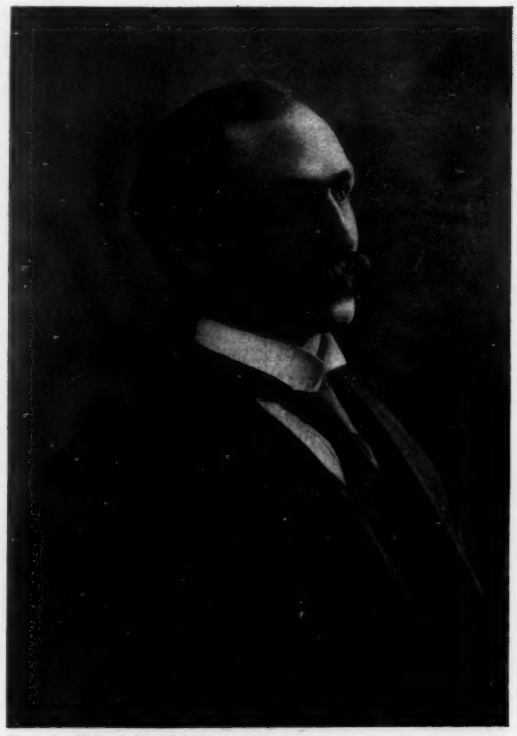

Photo. by Hills & Saunders.]
HENRY BALFOUR.

built up by a process of evolution; and he was led to believe that the same principles must probably govern the development of the other arts, appliances, and ideas of mankind. On this belief and principle his collection was formed.

Section I.—Physiology.—Correlation of Nerve-Arcs.

PROFESSOR SHERRINGTON, M.D. and D.Sc., Cambridge; LL.D. Toronto; made Fellow of Royal Society in 1893; and Honorary Member of the Academy of Medicine in Vienna. Has been given the Marshall Hall Prize and the Baily Medal. His chief work has been on the nervous system. Eight years Lecturer on Physiology at St. Thomas's Hospital, London, and four years Professor Superintendent of the Brown Institute, London.

Professor C. S. Sherrington began his address to the Physiological Section with a definition of the points of view from which physiology studies the nervous system. They were three. One of them regarded its processes of nutrition. Such processes could be followed in the nerve cell, as in other cells. But the cells of the nervous system had certain functions which were specialised; and one of these was the power of the nervous cell to transmit states of excitement—a power which was called conductivity. The examination of this property was the second problem. The third was the investigation of the way in which by this conductivity the separate cells and units of an animal body were welded into a single whole, and how from a mere collection of organs there was made a single animal. It was one of the general problems of this third branch of inquiry to which Professor Sherrington invited the attention of his hearers; and the problem was concerned with the chain of conduction, and with the ways in which the nerve arcs, from a sense organ to a limb muscle, for example, are connected.

Photo. by Soper & Stedman.]
PROF. C. S. SHERRINGTON.

Section K.—Botany.—The Preception of the Force of Gravity by Plants.

MR. FRANCIS DARWIN, F.R.S., President of the Botanical Section, is the third son of Charles Darwin and of Emma Wedgwood, and was born 1848, at Down. (The Editors of "KNOWLEDGE AND SCIENTIFIC NEWS" asked Mr. Darwin if he would be kind enough to oblige them with some biographical particulars, and those that he has furnished are so interesting that it is thought desirable to leave them in their present form.) Mr. Darwin writes:—"I was educated at Trinity College, Cambridge (M.A., M.B.), and St. George's Hospital, London. When a medical student I worked at the Brown Institute under Dr. E. Klein, and this was my first real bit of education in science. Dr. Klein gave me some original work to do, part of which served as my thesis for the Cambridge M.B. Dr. Klein's influence made me desire to take up natural science rather than the practice of medicine, so that I was only too glad to accept my father's proposition, that I should act as his assistant. I lived at Down, working with my father till his death in 1882. I then moved to Cambridge where I ultimately became Reader in Botany and Fellow of Christ's, my father's old college.

"My scientific work has been in Physiological Botany, on which I have published various papers. My 'Practical Physiology of Plants' (1894) (for which the late E. H. Acton wrote the chemical part) has had some influence on the teaching of this part of botany, and is now in its 3rd edition. I also wrote a little book, 'The Elements of Botany' (1895), which gives the substance of my lectures to medical students.

"In 1887 I brought out 'The Life and Letters of Charles Darwin.' In 1892 an abbreviated version in one volume was published, giving the autobiography, my personal recollections, and a selection of the letters.

"In 1903, in collaboration with Mr. Seward, I brought out 'More Letters of Charles Darwin,' two volumes made up chiefly of letters which could not be included in the 'Life,' but also containing material obtained since 1887. During the present summer I shall resign the Readership of Botany and my Fellowship, and propose to live in London.

"Through the kindness of the Committee of the Chelsea Physic Garden, I am for the present provided with a laboratory, and with house room for my father's library, which I have been permitted to deposit in the lecture-room at the Physic Garden."

Mr. Francis Darwin's address to the Botanical Section was a summary of the knowledge that has been gained of the ways in which plants become sensible of the influence of gravity, and adjust themselves to its suggestions. As long ago as 1824 Dutrochet imagined that the movements of plants were dictated at the suggestion of changes in their surroundings rather than that they were the direct and necessary

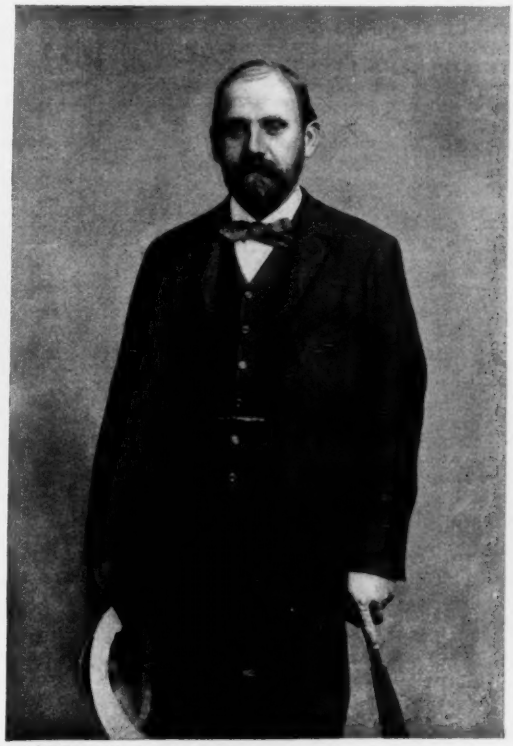

Photo. by Elliot & Fry.]
FRANCIS DARWIN.

result of such changes. Mr. Darwin has been in the habit of expressing the same thing in other words, using the idea of a guide or sign-posts, by the perception of which plants were able to make their way successfully through the difficulties of their surroundings. The force of gravity was one of the most striking features of a plant's environment; and in the sensitiveness of a plant to this force we had one of the most widespread instances of a plant's ability to read a sign-post and direct its growth accordingly. Mr. Darwin's paper reviewed the ways in which what might be called the sense-organs of plants transmit the knowledge throughout its organism, and the ways by which in theory these sense organs are affected by the outside influence.

Sub-Section.—Agriculture.

DR. WILLIAM SOMERVELLE, M.A., D.Sc., owned and farmed a small estate in Lanarkshire till 24. From 24 to 28 studied agricultural science in Edinburgh University during winter, and travelled on the Continent during summer. Secured Vans Dunlop Scholarship and went to Munich in 1888 to study forestry. Appointed Lecturer on Forestry, Edinburgh University, 1889. Professor of Agriculture and Forestry, Durham College of Science, 1891. Professor of Agriculture, Cambridge, and Professorial Fellow of King's College, 1899. Assistant Secretary to the Board of Agriculture, with charge of the Branches of Intelligence and Education, 1902. Started experi-

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menta farms in Northumberland and Cambridge. Chiefly identified with experimental work on finger, and, toe in turnips, and with the influence of manures on the feeding properties of pasture. Graduate of Edinburgh, Munich, Durham, and Cambridge. Has served on Departmental Committees on Forestry, Sheep Parasites, and Fruit. Written a good deal on agricultural and forestal matters.

Dr. William Somerville, the President of the new Sub-Section of Agriculture, took for his subject "Recent Work in Agricultural Science"; and dealt successively with the latest experiments at Rothamsted; German work on the storage of farmyard manure, forestry, the Woburn Fruit Station, and the improvements in the scientific variation of crops. Dr. Somervelle also devoted some paragraphs to that fixation by electricity of atmospheric nitrogen, which, as Sir William Crookes hoped, might some day provide us with artificial nitrates and cheaper manures and soil stimulants. This work was going on well, said the President, and he believed agriculture would not have long to wait before it was placed in

Photo. by Moffat.]
DR. WILLIAM SOMERVILLE.

possession of "that most powerful agent of production." The President also reviewed the partial failure of the attempt to supply artificially the bacterial organisms which are naturally found at the nodules of leguminous plants, and so stimulate their growth. These bacterial cultures—"nitragin," as the experimental samples were called—had been a failure of late when applied on a large scale; but both in Germany and the United States, where faith and belief in the value of "nitragin" was considerable, the experiments were being vigorously pursued with what was called "improved nitragin."

Section L.—Educational Science.

THE RT. REV. JOHN PERCIVAL, D.D., Bishop of Hereford. Born 1834, son of William Percival, Brough, Sowerby, Westmoreland, and Jane, daughter of William Longmire, Bolton, Westmoreland. Married first, 1862, Louisa, daughter of James Holland (died 1896), and second, 1899, Mary Georgina, daughter of the late Frederick Symonds, F.C.S., Oxford. Educated at the Grammar School, Appleby, Westmoreland, and Queen's College, Oxford, of which he was a Scholar. Junior Mathematical University Scholar 1855, Double First Mods and Finals; M.A., 1861. Fellow of Queen's College, Oxford. Ordained, 1860. Assistant Master Rugby. Headmaster Clifton College, 1862-1878. Prebendary of Exeter, 1871-82. Canon of Bristol, 1882-7. President Trinity College, Oxford, 1878-87. Headmaster Rugby, 1887-1895. Bishop of Hereford since 1895.

The Presidential address to the Educational Section was an attempt to define the limits of investigation which science might usefully set itself in dealing with education. In the consideration of these limits it was necessary to give due regard to right ideals of moral and social progress as a primary part of the whole; and it was necessary to decide what methods of investigation were appropriate and what were inappropriate to the duty of education. The Bishop of Hereford went on to

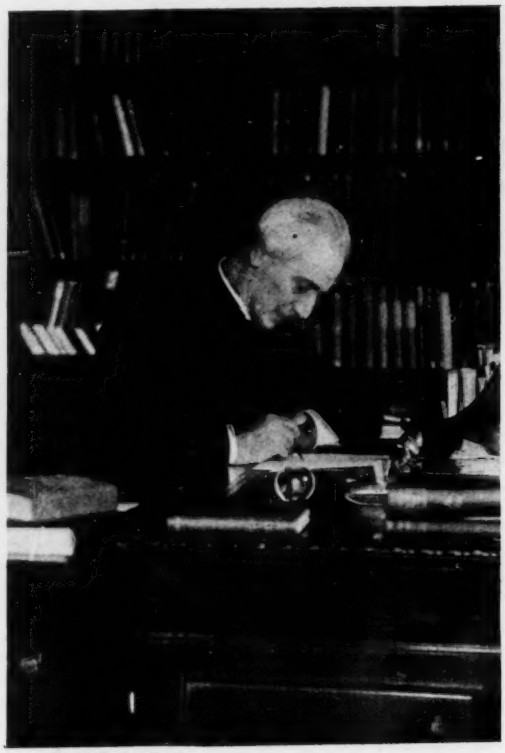


Photo. by W. H. Bustin.]
THE RIGHT REV. THE LORD BISHOP OF HEREFORD.

criticise the various defects in the national outlook on education; and in the various systems of primary, secondary, and public school education; and he laid down the general principle that one of the things needed for the general improvement of our secondary education was that every private school, of whatever kind, should be liable to public inspection and public report thereon; that a licence should be required for every such school; and that the staff and their qualifications, and the remuneration given to each of them, the sanitary condition, suitability and educational equipment of the premises, should all be considered in connection with the giving or withholding of a licence.

THE FOREIGN GUESTS.

UPWARDS of 200 American, Canadian, and foreign men of science attended the Cambridge gathering of the Association. We append a few details respecting the scientific achievements of some of the more familiar names, limitations of space forbidding extended reference.

American and Canadian.—PROFESSOR W. O. ATWATER, who lectured in the physiological section on "Nutrition Experiments on Man in the United States," has occupied the chair of Chemistry in the Wesleyan University, Middletown, since 1873. On the establishment of the Connecticut Agricultural

Experiment Station—the first of its kind in the United States—he became Director, and engaged in the important nutrition investigations promoted by Congress in connection with the Experiment Stations of the United States Agricultural Department. The Carnegie Institution has granted £1000 in furtherance of this work, and £1300 to Dr. Arthur Gamgee, F.R.S., of Montreux, for the preparation of a report upon the results so far attained. Professor Atwater has published numerous papers in physiology.

PROF. W. B. SCOTT, of Princeton University, New Jersey, is best known for his labours in the elucidation of the fauna of Santa Cruz; also for investigations connected with the Princeton Expedition to Patagonia. The results of the latter will be completed during the next few years in eight volumes, somewhat after the model of the "Challenger" series of zoological reports. Mr. J. Pierpont Morgan has given a subsidy towards the issue. The first instalment, under the editorship of Professor Scott, bears ample testimony to the importance of the researches, while being highly creditable to American zoological workers.

PROF. A. B. MACALLUM, who holds the Chair of Physiology in the University of Toronto, is well-known for his researches in histology and physiology; and is a teacher of repute. He took a prominent part in the founding of the Canadian Marine Biological Station at St. Andrews, North Brunswick, as well as that at Canso, Nova Scotia. He is the author of many papers, including, "On the Distribution of Iron in Animal and Plant Cells" (Brit. Assoc. 1897); and "On the Localisation of Potassium in Animal and Plant Cells" (Brit. Assoc. 1903).

PROF. A. LAWRENCE ROTCH, a distinguished meteorologist, is Director of the Blue Hill Observatory, U.S.A., librarian of the American Academy of Sciences, and a Chevalier of the Legion of Honour. His observatory was established in 1885, and from thence have been issued from time to time the results of novel investigations of the upper air. He was the first to obtain accurate meteorological records over the Atlantic by means of cloud observations and self-recording instruments lifted by kites.

PROF. JOHN DEWEY is Director of the School of Education and Professor of Philosophy in the University of Chicago. He held formerly similar positions in the Universities of Michigan and Minnesota. Professor Dewey is an authority upon the psychology of numbers, and author of a work on the Theory of Ethics.

PROF. R. W. WOOD, of the Physical Department of the University of Wisconsin, who belongs to the younger school of American physicists, is well known in English scientific circles. In 1900, he read a paper at the Royal Society on the "Photography of Sound Waves," and at the Society of Arts on the "Diffraction Process of Colour Photography." He is possessed of striking experimental originality, which gives him such a mastery over simple forms of apparatus as to make those accustomed to work only through the medium of more elaborate means somewhat envious of his laboratory and teaching methods. On the occasion of one of his summer visits to San Francisco, struck with the beautiful miniature mirages to be seen during sunlight on certain of the flagstoned sidewalks, he set himself with success to secure a photograph of the phenomenon. At the recent meeting Professor Wood contributed a paper on "Colour Photography."

PROF. RAMSAY WRIGHT, Vice-President of Toronto University, is also Curator of the Biological Museum and Professor of Biology in the University. His writings upon the comparative anatomy of vertebrates are numerous. He has prepared a special report upon the Fish and Fisheries of Ontario.

Foreign.—M. YVES GUYOT was formerly Minister of Public Works in Paris. The publications of the Cobden Club, of which he is an honorary member, have made his writings on economic subjects, and particularly on the tenets of Free Trade, familiar in this country. M. Guyot was recently the recipient of the "Guy" Medal of the Royal Statistical Society for his paper, "The Sugar Industry on the Continent."

DR. JOSEF KÖRÖSI, Director of the Bureau of Municipal Statistics at Budapest, is a distinguished member of the Hungarian Academy of Sciences. Under his supervision valuable reports are issued from time to time dealing with mortality and other branches of the science of Demography or Vital Statistics. A voluminous paper on "Natality" was communicated personally by him to the Royal Society in 1894, and afterwards published in the *Philosophical Transactions*.

DR. PAUL GROTH is Professor of Mineralogy and Crystallography in the University of Munich, and Keeper of the Collection of Minerals. His studies have earned for him a European reputation. In 1877 he established the *Zeitschrift für Krystallographie und Mineralogie*, and in 1902, to mark the 25th year of issue of the journal under his editorship, an English Committee of Mineralogists, Geologists, and others presented the Professor with his portrait, painted by Grützner, of Munich. On the occasion of his visit here, the University of Cambridge conferred on him the degree of Doctor of Science.

DR. A. SOMMERFELD is Professor of Mechanics in the Royal Technical School, Aachen, Prussia. In a paper on the "Scientific Results and Aims of Modern Applied Mechanics," lately published, he has emphasised the desirability of a more practical application of the principles of mechanics from the teaching standpoint.

PROF. OSCAR MONTELIUS of the State Museum of History and of Numismatics, Stockholm, is eminent for his researches upon the ancient civilisation and antiquities of Sweden and other Scandinavian countries. It may be mentioned that the subject of his contribution at Cambridge—namely, the evolution of the lotus-ornament—had already received attention at the hands of Mr. W. H. Goodyear in the *American Journal of Archæology*, 1891, in his paper, "The Grammar of the Lotus." The results of Professor Montelius' study will be awaited with interest.

M. HENRI BECQUEREL, Professor of Physics in the École Polytechnique, Paris, has a world-wide reputation on account of his epoch-making experiments with the mineral uranium, whence has sprung the new knowledge, "radio-activity." In 1896 he discovered that salts of uranium emitted a radiation which was capable of affecting a photographic plate after traversing thin metallic screens; also that the rays possessed the power of making gas through which they passed a conductor of electricity. Many will recall Professor J. J. Thomson's evening lecture at the British Association meeting of 1902, "Becquerel Rays and Radio-Activity." Professor Becquerel comes of a line of distinguished physicists. His grandfather and father were both Foreign Members of the Royal Society, the former a Copley Medallist of that body; while the Professor himself has received its Rumford Medal. He was awarded the great Physics prize of the Nobel Institute last year, conjointly with M. and Mme. Curie.

DR. ERICH VON DRYGALSKI, Professor of Geography in the University of Berlin, was Scientific Director of the recent German Antarctic Expedition in the *Gauss*, which sailed early in 1902, and returned last year after accomplishing much successful work. Dr. von Drygalski read a paper dealing with the results of the Expedition before the Geographical Section of the Association.

DR. R. LIVY, of the Italian Ministry of War, Rome, is a distinguished anthropologist. His attendance at Cambridge was specially sought in order that his experience in methods of anthropometry might be available in discussions in Section H. on the advantage of a British anthropometric survey. Dr. Livy has recently embodied the results of anthropometric investigations among the troops of the Italian Army in the work, "Anthropometric Militaires."

Comparative Legislation.—Included in the second part of Vol. V. of the "Journal of Comparative Legislation" (John Murray) are articles on English and Continental military codes, by J. E. R. Stephens; "Obeah" in Jamaica, by S. Leslie Thornton; International Railway Transport, by G. C. Phillimore; and contributions concerning the Antwerp Conference, by Mr. Justice Kennedy and T. G. Cower, K.C.; and on a Council of the Empire by the Hon. W. P. Reeves and Professor T. E. Holland, K.C. Sir John Macdonell writes on Contracts for Labour, and the late Sir William Rattigan on the great jurist Bartolus. The volume is prefaced by a portrait and a biographical notice of the Rt. Hon. R. B. Haldane.

XUM

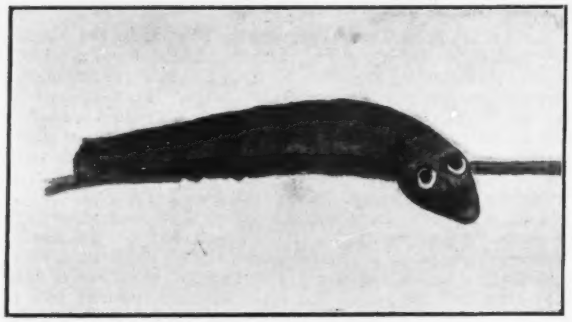
Terrifying Masks and Warning Liveries.

By PERCY COLLINS.

IT has been suggested—and the theory has received, to some extent, the support of experimental proof—that certain kinds of insects derive protection from the grotesqueness or hideousness of their appearance. An oft-cited example is the very remarkable-looking caterpillar of *Stauropus fagi*, the lobster moth. This insect was at one time considered a great rarity in England, and as such was much prized by collectors. Of recent years, however, it has been found in considerable numbers in the beech woods of the Upper Thames valley, and entomologists have had ample opportunity to examine its appearance and habits in the wild state.

Professor Poulton describes the resting caterpillar as possessing a considerable resemblance to a withered leaf irregularly curled up—the likeness being gained by the combined effect of the creature's colour, its curiously modified legs, and the manner in which these are arranged.

It is clear, therefore, that this remarkable larva is concealed from its enemies by a protective likeness to its habitual surroundings. But it has yet another means of defence at its disposal. Should it be disturbed by a rustling of the leaves and twigs in its immediate neighbourhood, and become convinced that its disguise has been penetrated, it immediately assumes what has been called its "terrifying attitude."

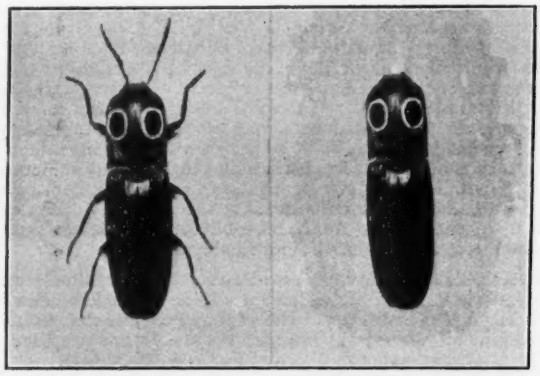


Larva of *Chaerocampa Porcellus*, in terrifying attitude (drawn from life).

In this position it is described as looking very like a large spider, but with all the characteristic points in a spider's appearance greatly exaggerated for the sake of effect. The legs and body are, for the time being, arranged in such a manner that the creature seems changed from a harmless caterpillar into something strangely disquieting to look upon.

In thus mimicking the attitude and appearance of an exaggerated spider, the lobster moth caterpillar is really trading upon the reputation of a well-recognised noxious creature; and the defence has been shown by experiment to be of no little avail against the attacks of birds and other insect-eating creatures, which exhibit varying degrees of alarm and disgust at sight of the caterpillar in its terrifying attitude. But, as several observers have pointed out, it is more than likely that the spider-like appearance exists mainly as a special safeguard against the insect enemies of *Stauropus fagi*. In common with the larvæ of most Lepidopterous insects, this caterpillar is liable to the attacks of ichneumon flies, which deposit their eggs upon or beneath its skin. In the majority of instances such "stung" larvæ die miserably ere they are able to assume the imago state; and it is only reasonable to assume that any trick or device calculated to scare away these insect foes would directly benefit the species by enabling a greater number of its caterpillars to arrive at maturity. And as a large and presumably ferocious spider is a vision of dread to all the lesser denizens of the insect world, the lobster moth caterpillar's terrifying mask is probably very effective.

Larva of *Chaerocampa elpenor*, showing "eye spots" on fourth and fifth segments of body.

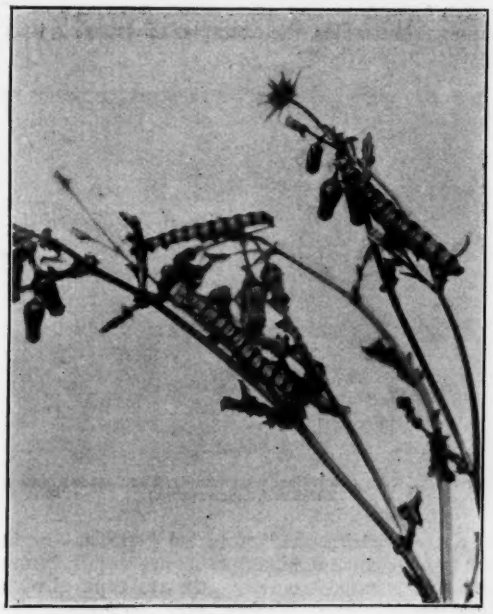


***Alaus sp.* Central America. As it appears when running; and when, under the stimulus of alarm, it has drawn its legs and antennæ beneath its body.**

Similar instances of what looks like trading upon the reputation of some well-known noxious creature occur among insects, and in some instances the prototype seems to belong to some widely different group of living creatures. Thus, a South American caterpillar mentioned by Mr. Bates startled everyone to whom it was shown

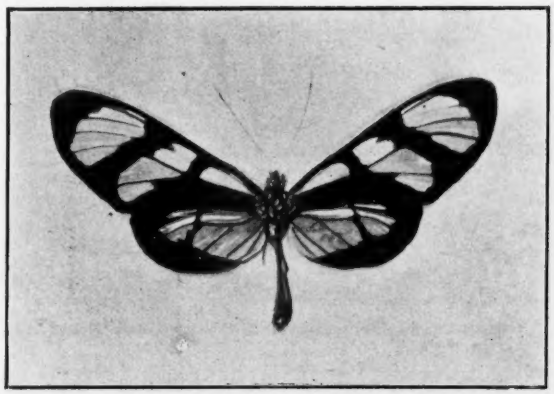
by its snake-like appearance; while among our native species the larvæ of the two elephant hawk moths (*Chaerocampa elpenor* and *C. porcellus*) are striking instances of a protection gained in a similar manner.

Like the caterpillars of the lobster moth, those of the elephant hawks are difficult to detect when they are at



Larvæ of *Euchelia jacobææ*.

home among the leaves of their food plants, owing to their brown—or more rarely green—colouring. But when actually discovered, or when thoroughly alarmed by the rustling of the leaves, the caterpillar draws back its head and the first three segments of its body into the fourth and fifth segments. What then happens is well

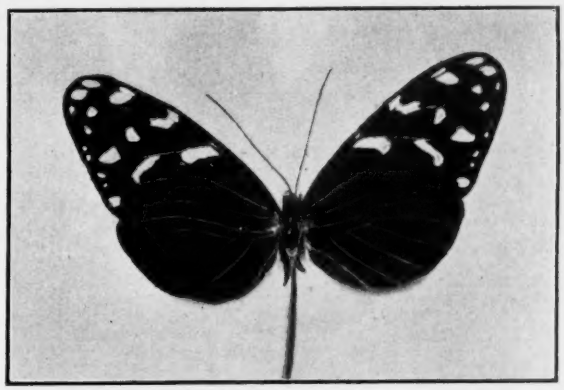


Methoma themisto. **Ex Rio Granda (black, with "clear" areas).**

described by Professor Poulton. "These two rings (the fourth and fifth segments) are thus swollen, and look like the head of an animal upon which four enormous, terrible-looking eyes are prominent. The effect is greatly heightened by the suddenness of the transformation, which endows an innocent-looking animal with a terrifying and serpent-like appearance."

This description applies to the *C. elpenor*. In the case of *C. porcellus* the eye spots on the fifth segment, though present, are comparatively inconspicuous. It is a curious fact that these strange markings do not attract particular attention when the caterpillars are quietly at rest or feeding. As soon, however, as they assume their terrifying mask, under the stimulus of apprehended danger, the staring "eyes"—owing to the swelling of the segments as the head and first three body rings are withdrawn—become enormous and prominent. All field entomologists who are familiar with these caterpillars in the wild state are willing to bear testimony to their startling appearance when they have assumed their terrifying attitude.

Very similar eye spots, probably of a like protective value, are seen upon the thoraces of certain Central American beetles of the genus *Alaus*. As in this case the markings are delineated upon the hard surface of the thorax they are not really more marked at one time than another. Yet their terrifying appearance is enhanced considerably when the beetle assumes the attitude with which it responds to indications of approaching danger. In common with most species of the great "click-beetle" group *(Elateridæ)* to which the genus *Alaus* belongs, these insects are capable of folding their legs and antennæ so



Melinea mesatis. **Ex Columbia, S.A. (red, brown; anterior areas of fore-wings black, spotted white).**

closely beneath the body that they are completely hidden, and of remaining perfectly quiescent in this attitude for a long period of time. A glance at the accompanying photograph will give the reader some idea of the weird appearance of an *Alaus* beetle under these conditions. It cannot be said to resemble any other living creature, noxious or innoxious. Yet its appearance is sufficiently forbidding to discourage hostile attack.

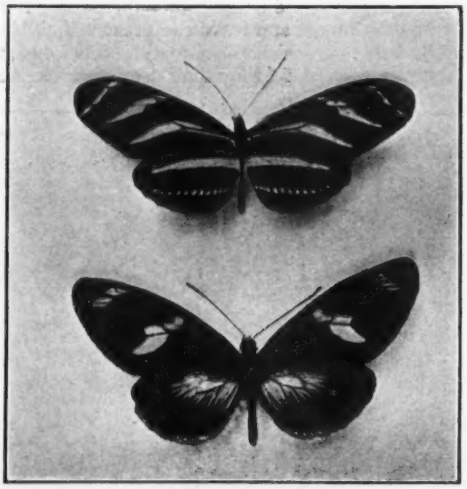
In dealing with the first part of our title we have briefly discussed several insects which are able, at will, to masquerade as something terrible and alarming. They can put on, as it were, terrifying masks, and scare away their would-be persecutors. But the protection thus gained is the outcome of bare-faced bluff, and it is conceivable that the enemy may one day discover and profit by this fact. Warning liveries, on the other hand, are anything but meaningless bluster. They indicate that the creatures distinguished by them possess certain noxious characteristics which render them unwholesome or unpalatable.

At the present day, students of entomology accord a fairly general acceptance of the theory of warning coloration as explaining certain extremely striking colours and colour contrasts which occur throughout the insect world. In cases of protective colouring, the

XUM

insects resemble more or less closely those objects by which they are habitually surrounded—the protection becoming more certain in proportion to the completeness of the likeness. But with warning colours, exactly the reverse is the case. Insects assignable to this class are not coloured to be hidden, but in order that they may readily be seen.

It is believed—and in many instances this is definitely known to be the case—that such conspicuously coloured insects possess some hurtful quality which renders them inedible, and that their showy livery acts as a warning to insectivorous creatures in general. The reason why warning colours are thought to benefit a species is explained in the following manner. Insects are, for the most part, very frail creatures, and one peck from a bird bent upon testing the edibility of (say) a caterpillar, would, in all probability, result in the creature's death. Thus, the mere fact of its being unsuitable for food would be of no avail in saving its life. But if the caterpillar were coloured in a manner sufficiently striking to become impressed upon the mind of the bird, a distinct advantage to the species might be expected to result. For the bird, presuming it to be capable of learning a lesson, would give up "experimental tasting" in so far as insects coloured in a similar manner were concerned.

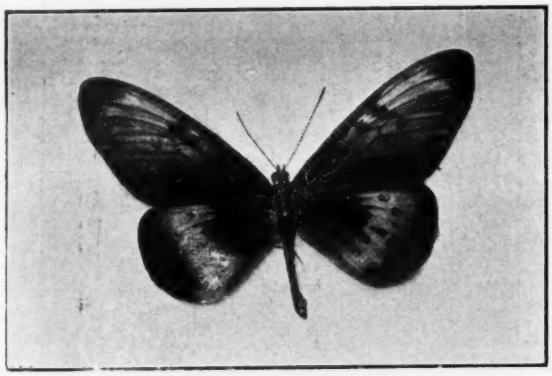


1—*Heliconia charithonia*. 2—*Heliconia quirina*. Ex Trop. South America. The Heliconiidæ have all dark brown or black wings, lined or spotted with very brilliant colours.

As an example of a warning colour combination by no means uncommon in the insect world, the caterpillar of the Cinabar moth (*Euchelia jacobææ*) which is zebra striped in alternate bands of black and yellow, may be cited. This larva has been proved to be nauseous in taste, and to be rarely eaten by birds or other insectivorous creatures old enough to have gained experience in "the ways of the world." The same yellow and black striping is to be seen upon the bodies of many species of wasps and bees—insects which would prove very unsatisfactory eating on account of their poisonous stings.

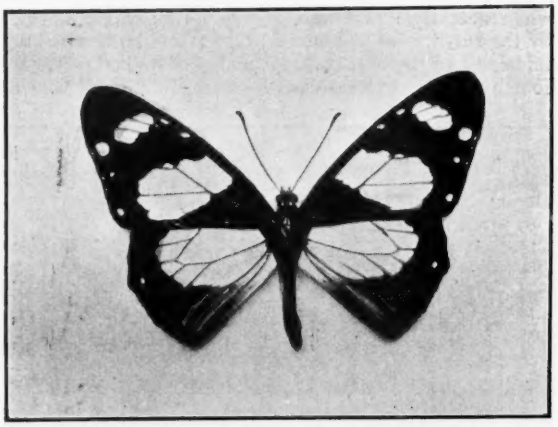
The theory of warning coloration was first suggested by Dr. A. R. Wallace to account for the extremely bright colours exhibited by certain caterpillars. It has since been applied to whole tribes of insects, of all orders; and so strong is the evidence in its favour—the result of systematic experiments conducted in various latitudes with birds, lizards, and other insect-eating creatures—that what was originally a theory may now fairly be regarded as a well-established fact. Indeed, so distinct are the colours and colour combinations possessed by inedible species, and so unlike are they to the colours of insects which do not possess noxious qualities, that the student is frequently able to tell at a glance whether a given species is an example of warning coloration or not, even though he may never before have seen it.

Amongst butterflies, the examples of warning liveries are particularly striking.



Acraea sp. Ex Sierra Leone (fore wings sooty, black spots; hind wings brick red, black spots).

In South America, the "protected" species—as those which possess some noxious quality are usually termed—are exceedingly numerous, and are well typified by such genera as *Methoma*, *Melinea*, and *Heliconius*. These butterflies are rendered inedible by the acrid or evil-smelling juices contained in their bodies. Even in the case of long-dead specimens which have been temporarily



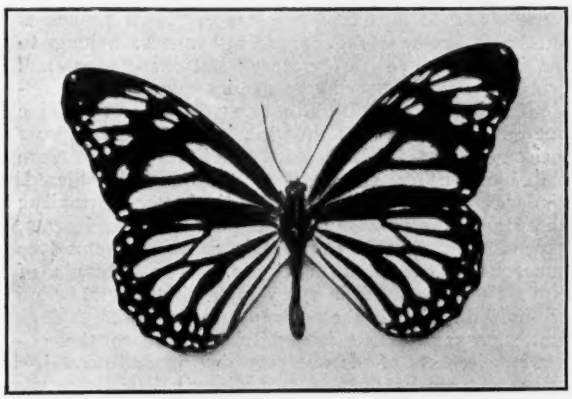
Amauris ochlea. Ex South Africa (blackish-brown, with white areas).

relaxed for setting, the unpleasant odour of these juices is very apparent, resembling the scent which is left upon the fingers after handling a ladybird beetle. Such butterflies, in common with other evil-tasting species in other parts of the world, are slow and measured in their flight, fluttering in an unconcerned manner from flower to flower as though experience had taught them that they have little to fear from birds, reptiles, monkeys and other enemies to insect life.

Although the species of warningly coloured butterflies are exceedingly numerous in the New World, they are

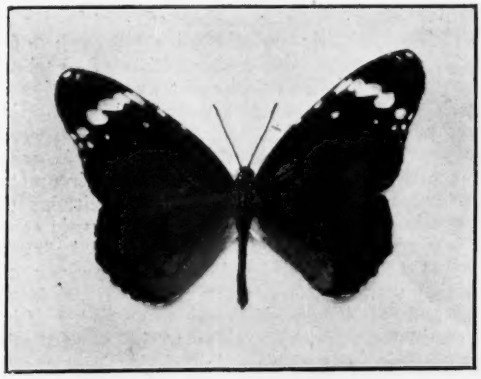
by no means unrepresented in other parts of the globe. In Africa, the genera *Acraea* and *Amauris* have a wide range, and are represented by many well-marked species. While in the Indo-Malayan region the great sub-family of the *Danainae*, all the members of which are rendered conspicuous by their warning liveries, is a dominant group.

The accompanying photographs represent a few common and very typical warningly coloured butter-



Danais edmondi. **Ex Philippines (white and black).**

flies, and a glance at them will give the reader a better idea of the special designs associated with inedibility than could be gained from a mere description. It will be seen that the aim is to produce a startling effect; one, moreover, that will not easily be overlooked or confused. On contrasting such warning liveries with the tints of insects which are wholly or partially protectively coloured to harmonise with their surroundings, it becomes very obvious that designs so different must have been pro-



Danais Chrysippus. **Widely distributed in Eastern Hemisphere (fulvous-brown, marked with black and white.**

duced in response to equally diverse circumstances. It is, moreover, worthy of note that warningly coloured butterflies, as a rule, differ little in the tinting of the upper and under surfaces of their wings; whereas butterflies unprotected by inedible qualities, even though they may possess brightly coloured upper surfaces to their wings, usually have them tinted beneath in harmony with leaves, bark, sand or rock. Thus, as soon as they settle with folded wings, their protective colouring comes into play.

Modern Cosmogonies.

By MISS AGNES CLERKE.

X.—The Forms of Nebulae.

SIR WILLIAM HERSCHEL'S celestial surveys first made the classification of nebulæ practicable. Until he began grinding specula at Bath very few such objects were known, and those too imperfectly for the effectual discrimination of their differences. Arrangement presupposes comparison, and comparison some variety of specimens to be compared, which became available only through Herschel's scrutiny. The rapidity and penetrative power of his observations in this field almost passes belief. He detected with discernment. Discovery and enrolment did not satisfy him; he was, besides, keen to note analogies and contrasts, likenesses and dissimilitudes. He could not see without at the same time setting in order what he saw; and the law of order that commended itself to him was founded on an evolutionary principle. The contents of the heavens seemed to fall spontaneously, as he regarded them, into genetic sequences; and the nebulæ with particular facility. The criterion adopted was that of progressive condensation. Development must clearly, he judged, be attended by contraction and local brightening. Diffused milky tracts represented cosmic formations in their most rudimentary form; they assumed, through the unremitting action of gravity in drawing their particles together, a more compact texture, more definite shapes, and a heightened lustre.

But things have changed somewhat in aspect during the last hundred years. Herschel's simple rule of arrangement, although of unquestioned validity, needs to be supplemented by others. Much auxiliary knowledge has been acquired since it was formulated. In attempting to estimate the comparative antiquity of nebulæ, we no longer depend exclusively upon one set of indications. The conclusions drawn from their immediate inspection can at least be checked by the study of their spectra and distribution.

The Milky Way might be figuratively described as the nursery-garden from which the parterres of the universe are stocked. A primitive condition is usually assigned, not without good reason, to any class of objects markedly tending to collect in its plane. And this is the case with gaseous, or "green" nebulæ. Moreover, their materials appear to be in a highly elementary state (if it be permissible to speak of one kind of matter as more elementary than another); their spectra including no rays due to metallic incandescence, but mainly those of nebulium, hydrogen, and helium. These substances, inconceivably attenuated, constitute the vast irregular formations placed by Herschel at, or near, the start of cosmical development. And so far he has been justified by the outcome of modern research. But he has not been justified in his description of planetary nebulæ as "very aged, and drawing on towards a period of change or dissolution." For, despite their determinate shape and definite boundaries, they do not appreciably differ in composition from nebulæ of the "irregular" class, and must be reckoned as, in a manner, coeval with them.

There is, on the whole, a concurrence of evidence that gaseous nebulæ are at a very early stage of growth. They are the least elaborated of sidereal objects; they seem, many of them, barely to have crossed

the threshold of creation. Their mutual relations in time are, however, by no means obvious. They cannot easily be disposed in any kind of sequence. Each of the great nebulæ, at any rate, exhibits features and occupies a position shared by none of its fellows. The most discerning cosmologist cannot pretend to say that the Argo nebula, for instance, is of greater or less antiquity than the Orion or the "America" nebula. They are individual growths, simultaneous, not successive. The line of development indicated for them is rather towards the formation of star-clusters than of diverse nebular species. Thus the Pleiades may illustrate the probable future condition of the Orion nebula, the contained stars having gained predominance, though still wrapt in filmy swaddling-bands, later, presumably, to be shaken off.

Planetary nebulæ have much more in common than irregular nebulæ, and their minor varieties might, with some plausibility, be associated with differences in relative age. They are marked chiefly by the character of the nuclear star which, in nearly all such objects, appears to act as the pivot of the surrounding vaporous structure. The supposition lies close at hand that it is designed as a provision for the nourishment of the star —that the star gains in mass and light at the expense of the nebula, which it is eventually destined to absorb wholly and supersede. On this view, planetaries like the green glow-lamp at the pole of the ecliptic (N.G.C. 6543) should be regarded as the most advanced, while Webb's planetary in Cygnus (N.G.C. 7027) would exemplify an inchoate condition. In the former the central star is of 9.6 magnitude, and sharply stellar; in the latter it is double and diffuse,* perhaps a wide binary system in embryo.

The question is, however, still open as to the real nature of the connection between planetaries and their central stars. The pabulum-theory is a promising conjecture; but no facts with which we are acquainted stringently enforce it. Ideas on the subject will need complete revision if the traces of spirality noted from time to time in some of these peculiar objects prove to be of radical significance. The *oculi*, distinctive of the "Owl nebula" (N.G.C. 3587) as originally shown by the Parsonstown reflector, consisted of luminous traceries coiled round *two* interior stars,† but the appearance was either due to illusion, or became effaced by change, since the camera has refused to endorse it as genuine. The "helical" planetary in Draco,‡ however, is doubtless essentially a spiral conformation§; and Professor Schaeberle, by means of exposures with a thirteen-inch reflector of twenty inches focus, has compelled not only the Ring nebula in Lyra,‖ but the Dumb-bell in Vulpecula to betray the surprising secret of their whorled structure. Both these nebulæ give a spectrum of bright lines, and invention is baffled by the problem of building up gaseous materials into strongly characterised edifices. The materials, however, may not be purely gaseous;¶ or we possibly see (as Professor Darwin long ago suggested) merely illuminated streamlines of motion furrowing an obscure mass. But if this be indeed so, there is the further question to be asked: What direction does the motion take? Do the tides set inward or outward?

*Keeler, *Lick Publications*, Vol. III., p. 214.
†Rosse, *Trans. Roy. Dublin Society*, Vol. II., p. 93.
‡ First detected as such by Holden and Schaeberle in 1888, *Monthly Notices*, Vol. XLVIII, p. 388.
§ Deslandres, *Bull. Astr.*, Feb. 1900.
‖ *Astr. Jour*, Nos. 539, 547
¶ Maunder, *Knowledge*, Vol. XIX., p. 39.

Our spontaneous impressions are all in favour of concentrative tendencies. We cannot easily shake off centripetal prejudices. Our lives are passed under a regimen of central attraction, and we naturally incline to universalise our experience. Hence Herschel's scheme of sidereal evolution invites at first sight ready acceptance. Stars seem as if they could not act otherwise than as foci of condensation in nebulæ; the lucid stuff involving them must, apparently, with the efflux of ages, settle down towards their surfaces, and become absorbed into their substance. Such processes indeed, apart from counteracting causes, belong to the inevitable order of Nature; but these may, and probably do, exist. From sundry quarters the conviction is pressed upon us that cosmic bodies can drive out matter as well as draw it in. Repulsive forces insist upon recognition, and their effects become more palpable the more attentively they are considered. Under certain conditions they get the better of gravity; and stars may possibly, like cocoon-spinning insects, expend their organic energies in weaving themselves unaccountably educed envelopes. The example of Nova Persei is fresh in every mind, but we make no pretension to decide the controversy it raised. A dogmatic pronouncement is unadvisable where the unknown elements of the question obscure and outweigh those that are known. A less slippery foundation for reasoning is afforded by the permanently visible spiral nebulæ, and features charged with an emphatic meaning have been revealed in them by photographic means.

Looking at the entire contents of the nebular heavens, we find the spiral type very largely predominant. It claims more specimens, and emerges more distinctly with each development of delineative power. Its chief prevalence, however, is among "white" nebulæ, showing continuous spectra.

They are vastly numerous. Gaseous nebulæ are reckoned by the score, white nebulæ by tens of thousands. Moreover, they collect near the poles of the Milky Way,* while the gaseous variety crowd towards its plane, both branches of the family thus manifesting galactic relationships, though of an opposite character. Now these facts of distribution are not without indicative import as to relative age. There is a consensus of opinion that objects showing a marked preference for the Milky Way are at an earlier stage of growth than those withdrawn from it, and the inference derives countenance from the circumstance that nebulæ situated in high galactic latitudes shine with continuous light, those near the galactic equator with interrupted radiance. Yet it would be rash to assume that any individual nebula traverses these successive stages. The series could be satisfactorily established only if we could point to a number of intermediate instances, which seem to be almost wholly lacking. We cannot trace in nebular as we can in stellar growth the insensible gradations of progressive change. They are, perhaps, complicated in nebulæ by influences of a different kind from those which have gained the ascendency in stars. Diffusive effects may in them be more conspicuous than concentrative effects;† or a balance may be temporarily struck between antagonistic tendencies.

Spiral conformation is the real crux of nebular cosmogony. The conditions from which it arises are

*Dr. Max Wolf places the point of nebular concentration in R.A. $12^h\ 53^m$, D. $+\ 61°\ 20'$, that assigned to the galactic pole being in R.A. $12^h\ 49^m$, D, $+\ 62°$. *Königstuhl Publ.* Bd. I. p. 174.
†T J. J. See, "Repulsive Forces in Nature," *Pop. Astr.*, No. 100, Dec. 1902.

met with only in the sidereal heavens, but are there widely prevalent. Though remote from our experience, they are fundamental in the realms of space. If we could define and comprehend them we should be in a better position for determining the cosmical status of nebulæ.

The choice is open between two rival theories of nebulous spirals. The first is the more obvious, and readily falls in with admitted mechanical principles. Sir Robert Ball has adopted and ingeniously advocated this view.

A globular collection of promiscuously revolving particles inclines, if left to itself, to flatten down into a disc. The reason is this: In a system of the kind, moment of momentum is invariable, while energy constantly diminishes. To render the contrast intelligible we have only to consider that moment of momentum is the algebraic sum of all the products of mass and motion in the aggregation, reduced to, or projected upon its "principal plane," while energy is independent of the varied directions of velocity. Collisions consequently involve no diminution of moment of momentum, but combine with radiative waste to produce a steady loss of energy. Inevitably, then, the system will assume the form in which it possesses the minimum of energy that is consistent with the maintenance of its original momentum; and it is that of a disc extended in the principal plane. Retrograde movements will by this time have become eliminated; the constituent particles circulate unanimously in one direction; and Sir Robert Ball adds that their circulation, owing to the more rapid rotation of the central mass, is along spiral paths.* They would accordingly present the twisted conformation so commonly observed in the heavens, and might even include subordinate centres of attraction, fitted to ripen and strengthen into a full-blown retinue of planets. Such are spiral nebulæ regarded in their direct mechanical aspect. Spherical nebulæ are their immediate progenitors; suns, with or without trains of dependent worlds, their lineal descendants.

Let us, however, consult some autographic records and weigh attentively what these peculiar objects tell us about themselves. We see at once that their curving lines are not laid down at hap-hazard, but according to a strictly defined plan. Spiral nebulæ are not formed like watch-springs by the windings of a single thread. They are always two-branched. From opposite extremities of an elongated nucleus issue a pair of nebulous arms, which enfold it in double convolutions. Their apparent superposition and interlacements occasion, in the Lyra nebula, the noted effect of a fringed and ruptured annulus, and it is of profound interest to perceive that even in gaseous masses the same constructive rule prevails as in the great Whirlpool in Canes Venatici.

It is, however, almost irreconcilable with the hypothesis that an influx of material is in progress. Falls due to gravity could not be limited to two narrow areas on the central body. Matter ejected from it might, on the other hand, quite conceivably follow this course. Interior strain could easily be supposed to cause yielding along a given diameter, and nowhere else. Solar disturbances partially and dimly illustrate such a mode of action. Diametrically opposite prominences are not unknown. They indicate the action of an explosive force right across the solar globe. Similarly, the formation of a spiral nebula cannot be rightly apprehended otherwise than as the outcome of long-continued, oppositely directed eruptions.

The history of the heavens involves the law of spirality. The scope of its dominion continually widens as research becomes intensified. The Huygenian "portent" in the Sword of Orion now figures as merely the nucleus of the "great winding Nebula" photographed by Professor W. H. Pickering in 1889. That the vast nebulosity encompassing the Pleiades is an analogous structure seems eminently probable, though the brilliancy of the enclosed stellar group obliterates most traces of its ground-plan. The magnitude of the phenomenon, we are told by Professor Barnard* who detected it in 1893 by means of a ten-hours' exposure with the Willard lens, transcends our powers of realisation. It covers 100 square degrees of the sky with intricate details. About four minutes of arc to the north-west of the Ring in Lyra lies a small nebula discovered visually by Professor Barnard in 1893, and photographically resolved by Keeler into a delicate spiral. It is a two-branched, left-handed spiral, as the large adjacent object has also proved to be. One is, in fact, the miniature of the other, and they are now shown, by Professor Schaeberle's short-focus reflector, to be linked together by winding folds of nebulosity into a compound spiral system. The Dumbbell is held, on the same authority, to be similarly conditioned, and the analogy frequently noted in the aspects of these remarkable formations has thus become incalculably widened in scale.

The galactic relations of the Magellanic Clouds are not easily defined. They are within the Milky Way, yet not of it. Enigmatical excrescences upon the universe, they suggest an origin from gigantic eddies in the onflowing current of sidereal arrangement. Their miscellaneous contents are, at any rate, disposed along eddying lines. Mr. H. C. Russell's photographs† rendered this, in 1890, to some extent manifest, and their indications were ratified by the Arequipa plates from the study of which Professor Pickering gained the conviction that the great Looped Nebula, 30 Doradus, is the structural nucleus of the Nubecula Major. "It seems," he wrote,‡ "to be the centre of a great spiral, and to bear the relation to the entire system that the nebula in Orion bears to the great spiral nebula which covers a large part of that constellation."

On all sides, in the sidereal heavens, we can discern the signs of the working of a law of convolution. Sometimes they are patent to view; sometimes half-submerged; but they can generally, with attention, be disentangled from overlaying appearances. They are exhibited by stars no less than by nebulæ, as the late Dr. Roberts pointed out from convincing photographic evidence; the "hairy" appendages of globular clusters betray them by their curvilinear forms; they meet us in every corner of the wide nebular realm. Many investigators recognise in the Milky Way itself the stamp of spirality. Stephen Alexander, of New Jersey,§ regarded the majestic galactic arch as a four-branched spiral, resulting from catastrophic breaches in a primitive, equatorially loaded spheroid, the streams of matter ejected by which should, owing to their lower angular rotation, lag behind as they retreated from the nucleus, and thus flow along helicoidal lines. R. A. Proctor subsequently devised convoluted

* *The Earth's Beginnings*, pp. 243-7.

* *Monthly Notices*. Vol. LX., p. 259.
† See *Knowledge*, Vol. XIV., p. 50.
‡ *Harvard Annals*, Vol. XXVI, p. 206.
§ *Astr. Jour.*, Vol. II., p. 100, 1852.

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galactic streams, which, however, corresponded imperfectly with what the sky showed. And M. Easton * has designed an elaborate series of spires, originating possibly from that vague entity, the "solar cluster," the projection of which upon the sphere may, he thinks, account for the noted peculiarities of the Milky Way. Our interior situation, nevertheless, makes it extremely difficult to determine the real relations in space of the star-streams circling around it. The observed facts are, perhaps, equally compatible with many other structural schemes besides those based on the idea of spirality; and the wiser course may be to adopt none, for the present, with settled conviction. We can, however, gather one sufficiently definite piece of information regarding the history of the Cosmos. All the inmates of the heavens, stellar and nebular, represent quite evidently the *débris* of a primitive rotating spheroid. Its equator is still marked by the galactic annulus, its poles by a double canopy of white nebulæ. The gyrating movement which it once possessed as a whole doubtless survives in its parts, but ages must elapse before the fundamental sidereal drift can be elicited.

Astroph. Jour., Vol. XII, p. 158.

Variability in Sociology.—I.

By J. COLLIER.

To most readers, perhaps, and certainly to all non-biologists, the chapter in *Darwinism* on the variability of species in a state of nature must have been nothing less than a revelation. Did the elder naturalists believe that Nature, having once for all formed her moulds and run into them her myriad species, had then gone to sleep? Here she was shown to have broken all moulds or to be incessantly making new ones. Did thinkers who accepted Darwinism, but were unwilling to abandon metaphysics, mythologically conceive of the creative power as pushing ever upwards along certain definite lines towards a dimly perceived goal? Here was the old Proteus found to be mocking all predetermined plans, flowing in all directions, taking all shapes, and masquerading in all guises. The entire vegetable and animal world was observed to be, as Heraclitus of old vaguely guessed, in constant flux. Every organ and every attribute of every species knows of no stationary state, but changes continually, and on this base of shifting quicksand is securely founded the whole theory of biological evolution. On the same foundation rests all social evolution. A rich harvest is impossible in a still unploughed field, but an initial attempt is now made to prove that the same universality of variation prevails among sociological as among biological species.

Political.

The social organism resembles certain low animal organisms, and like them varies in size. By annexations, renunciations, and losses, a country thus varies from one generation to another, and such variations may affect its specific character. The composite Austrian Empire, before Hungary was granted its old franchises, was predominantly German, and its chancellors were German; with the enfranchisement of Hungary it became almost Hungarian, and had a Hungarian chancellor; since the annexation of Bosnia and Herzegovina in 1878 it has become pre-eminently a Slavonic power, and naturally has a Slavonic chancellor. By the annexation of Alsace and Lorraine in the seventeenth century, France gained a footing on the right bank of the Rhine and at the same time acquired a notable influence over German courts and German literature; since its loss of them, its political and literary influence has almost vanished. World-wide Spain controlled the policy of the Papacy in the sixteenth century, was dominant in the Council of Trent, and deeply influenced the literature of Europe; without her empire she has shrunk to the dimensions of a merely national organism. The extent of the English county measured the personal force of the count or earl and varied with that; how significantly this contraction or expansion may affect a whole people, we perceive from the part that the two large provinces of Yorkshire and Lancashire played all through last century in the public life of England.

The relative dimensions of social organism continually vary. The French *ancien régime* was the scene of incessant conflicts among the executive, legislative, and judicial bodies. By their refusal to register royal edicts and ordinances, by the amendments they made in them, and the regulations they annexed to them, the *parlements* (courts of justice) constantly encroached on the legislative power. They encroached on the Executive by claiming the right to control the administration and the finances. During the agitated period of the Fronde they carried the assertion of these prerogatives to the point of civil war. On the other hand, the king trenched on the Judicature by the hearing of appeals, by evocations to the privy council of cases pending before any of the courts, and by granting leave to individuals to plead before the privy council in the first instance. The same variations are observable to-day. Under the Second Empire the Judicature was subservient to the Executive; it has long been subject to the Executive or the Legislature in turn. These, again, continually encroach on one another's sphere, now the one and now the other having the pre-eminence. The Judicature, in its turn, poaches on the preserves of the Legislature. "At a time of much hastily and recklessly devised legislation," remarks the Vicomte d'Avenel, "it illuminates, corrects, completes, or lets fall into desuetude the intentions of the law-makers. Reflecting changes of opinion and manners," he adds, "the jury is also slowly re-making the penal code, repealing some of its provisions by refusing to give effect to them, modifying others, and practically instituting new penalties."

It was long a Liberal tradition that the history of England records a steadfast constitutional development from despotism to freedom. Its real evolution might be graphically exhibited by means of such a "diagram of variation" as will be found on p. 67 of Wallace's *Darwinism*. While the dimensions of the Kingdom or Empire have, on the whole, advanced, like the body of Sciurus there outlined, the chief organs—the Executive, the Legislature, and the Judicature—have grown by a succession of zig-zags, like the head, tail, and feet of the same animal. Now this or the other power is on the crest of the wave, now in the trough of the sea; and the variations are often steep and abrupt.

It is equally an American tradition that the same three great organs of the national life of the United States have each been so effectually confined within their peculiar spheres that they have never left them.

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The illusion is less and is yet real. All through their history each has pushed out in this direction and in that. Each has repeatedly tried to encroach on the domain of the others. Sometimes the President has the upper hand; sometimes Congress is on top; and the Supreme Court is continually repressing the expansion of Congress. The Senate and the House of Representatives are theoretically equal, but the Senate has grown at the expense of the House. In the States and the cities the Executive rises and falls with the character of the Governor or the Mayor; President Cleveland was popularly known as the Veto Mayor because of his unflinching exercise of his powers.

Ecclesiastical.

Perhaps it may be laid down as an axiom that all Churches and all religions have hived off sects and doctrinal varieties in exact proportion to their vitality. Buddhism has shown the fertility proper to hot countries, though it is not in the hottest countries that it has produced the most. While only eighteen sects were counted in Ceylon and Tibet, Chinese Buddhism has rejoiced in ninety-six.

Hinduism is equally marked by a propensity to develop new forms. Sir Henry Maine describes the Sikh religion as having a tendency to throw off sub-sects, each with novelties of doctrine and practice; and he adds that the same process goes on all over India.

Under the monotonous surface of Islam there is incessant variation. According to Baron d'Estournelles de Constant, the Algerian sects are innumerable and too fugitive to be seized. They appear, then suddenly disappear, and unexpectedly reappear elsewhere; they melt into one another, cross and ramify, change their name and their doctrines.

Early Christianity is the classical arena of sects and heresies. Eternal truths, it has been well said, are those on which man has varied most. "Every year, nay, every moon," wrote an ancient bishop, "we make new creeds to describe invisible mysteries." Gibbon distinguishes eighteen Arian sects, but declines to discriminate among the thousand shades of difference between Nestorius and Eutyches. In 1643 a Jesuit historian reckoned that there had been ninety heresies in all, but the estimate falls far short of the reality.

The half-ossified Greek Church furnishes the same evidence of vitality. Those best acquainted with Russia assert that new sects are there continually coming into existence, and that in such numbers as to defy numeration.

A winding-sheet has long lain over the soul of Spain, but its religious activity was at one time as great as its military and colonial ardour, and a Spanish professor has written a history of Spanish heresies in four big volumes.

Catholicism has various types. The sensuous Catholicism of the Italian differs from the sombre Catholicism of the Spaniard or the semi-Protestant Catholicism of the German. Travelling over Germany, M. Lavisse found different shades of piety in different countries, showing the rich variety of the religious sentiment. There is a great gulf fixed between the Ultramontane Catholicism of Maynooth and the very modern Catholicism of Baltimore.

Protestant Christianity is constantly hiving off new sects: some twenty years ago the *Times* estimated that 700 distinct denominations were spread over the surface of England. In the United States the number must be still greater. "From Roger Williams and Ann Hutchinson down to Abner Kneeland and William Garrison," writes Emerson about Boston, "there never was wanting some thorn of innovation and heresy."

Military.

Incessant variation on an immutable base is admitted by French military critics to be a summary of the history of the art of war. Procedures in use to-day are thrown aside to-morrow; rules valid one year are found to be inapplicable the next; and the tactics and strategy of one campaign are obsolete in its successor. Weapons are taken up, and dropped, and taken up again. Thus, the lance, which was being disused after the wars of 1866 and 1870 had apparently shown its inutility, came again into fashion before 1890; about two years ago (so it was stated) all German cavalry regiments were to be armed with it; since the Boer war it has been almost superseded by the rifle. The primitive mode of fighting was by straggling bands; as nations grew more crowded their armies fought in mass, and soldiers scorned to dodge a bullet or a shell; since 1870 troops fight in looser formation, as if the individual had come to be of more account. About 1889 charges of cavalry in mass were again favoured; since the South African war individualist fighting has once more come into vogue; but German military critics predict that in future European wars battles will be fought by gigantic masses. Among minor variations the South African war gave new birth to the mounted rifleman and the khaki uniform.

Ceremonial.

Habits and customs, manners and fashions obey the same unchangeable law of change. Recreations vary with the season and the year, and new ones are continually being devised. Croquet, tennis, rinking, cycling, golf, and ping-pong chase one another off the field. Fashions in dress are still more fugitive. The succession of female fashions is believed to embody the genius of caprice, but it could readily be shown that there is no excess in female attire that has not been matched and outdone by some whim or extravagance in male attire. While admitting that women's dress reveals "a great instability in details," Professor George Darwin holds that it "retains a general similarity from age to age." In point of fact, the costume of men and women alike, in every single item, has varied incessantly, in women no more than in men, in men no more than in women. With the vanishing of such apparitions as Cinq-Mars, Beau Brummell, and Count d'Orsay is not the scope of variation in male clothing sensibly lessened? Not by a hair's breadth. The splendour is gone, but the variety remains. The diagram of a century's coats would show hundreds of variations. A simple calculation would prove that so plain an article of male attire as a pair of trousers is susceptible of thirty or forty different shapes, and the tailor runs the gamut of most of them in a round of years.

Linguistic.

Mechanical inventions are so many variations in the practical sphere, and the records of the Patent Office show that a successful invention is only one among hundreds that have never come to fruition. But the grand human invention is language, and it, too, has grown by the selection of chance varieties among the myriads to which hand and voice are ever giving birth. The alphabet (to single out those arising from the art of writing) has been the theatre of endless variations that have not ceased even since the art of printing laid its leaden bands on the fluid mass. Place all existing

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or extinct alphabets in parallel columns, and all will be perceived to have sprung from a single ancestor—Phœnician or transformed Egyptian. The development has taken place in the manner of all organic evolution. Spontaneous slight variations, due to accident, convenience, necessity, or caprice, have made all of the daughter-alphabets to differ sensibly from the mother-alphabet. In some letters a diagonal stroke has been substituted for the perpendicular; in others, a curve gradually approaches the straight line, which ultimately prevails. The position of an angle is changed; a flourish is added to a letter at the bottom; a cross stroke has a preponderance to one side; a triangular or circular top degenerates into a thick line; other characters rise above or descend below the line, or shoot out at an angle; and so on. How far such fanciful variations may carry an alphabet we perceive in Black Letter or Old English, which, or a congener of it, has been stereotyped into the modern German alphabet. Even printing does not arrest development, but gives increased scope to it. The variants of the artist who designs calendars and initial letters are of the same nature as those which made the Etruscan and Greek alphabets to differ from the Phœnician.

Literary and Aesthetic.

The range of variation is, perhaps, widest in poetry, where the free spirit moves in an ideal world and half creates its own objects. First, the rhythm varies. The ancient Greek poets, Chaucer and the earlier English poets, and all who trusted to their ear, "counted in each line the accents and not the syllables." With the loss of inspiration and the stiffening of the æsthetic sense, the fashion set in of mechanically counting the syllables, and we have such poetry as Pope's. Chatterton and Coleridge revived the old practice, converted it into a method, and varied the double by a triple rhythm. Scott multiplied the variations, ringing the changes on "the position of the accent in each foot, the number of the accents, and the number of the syllables in each foot." Next, the line, couplet, or stanza varies. In the first history of English literature that has been fruitfully impregnated by the evolutionist idea, Professor Macmillan Brown has luminously traced the variations of metrical forms through the second half of the eighteenth century. Two stand out conspicuous—the heroic couplet and blank verse. In Milton blank verse reaches the high-water mark by its cunning inversions, its complex harmonies, and its sublimity. Then it is displaced for half a century by the heroic couplet. When it comes back its character has completely changed. Descriptive in Thomson, stilted and ethical in Akenside and Warton, simple and straightforward in Cowper, picturesque and suggestive in Rogers and Campbell, narrative in Southey and Landor, austere in Wordsworth, and plastic in the Brownings, it is once more richly musical in Tennyson. The rhymed couplet runs a similar gamut of variations. Lastly, the structure of the poem varies. There are five standard types of the sonnet; there are six chief variations of it in Italy, where it has been most cultivated; the French, too, have delighted in experimenting on it, and there is a succession of English varieties; while the sextet, or group of six concluding lines, has been rhymed in eighteen different manners.

It might be better to say nothing than to say too little on the highest province of man's activity, but a single instance may be adduced from the æsthetic sphere. Hardly anything seems more likely to be stereotyped than the music of an oratorio. Yet great diversities have marked both the score and the performance of the *Messiah*. The score has been edited by a succession of musicians. Mozart supplied new harmonies and new accompaniments. Hiller incorporated a version of his own with Mozart's score. Bridge tried to restore it as Handel left it. Prout fills up vacant harmonies, eliminates some additions, restores Handel's orchestration, and deletes Mozart's false counterpoint. To changes of score have been added variations of performance: the harpsichord has been disused; the organ is larger; the composition of the orchestra has varied at different periods; as have also the proportions of the band and the chorus. There have been many *Messiahs*.

Such are a few examples, culled from a multitude, of variations among sociological species. Evidently, the genius of variety, which has made the outer world so bright to eye and ear, has clothed in shapes as multiform the far more complex world of man's social strivings and achievements. May we not conclude that civil as well as natural history presents unasked all those new openings and new paths which, selected and pursued, lead to higher stages of civilisation?

Some Tibetan Animals.

By R. LYDEKKER.

NATURALISTS are speculating whether the opening-up of Tibet, which is practically sure to follow the present expedition to Lhasa, will result in the discovery of any new animals of special interest. So far as the smaller mammals, such as mice, rats, squirrels, shrews, &c., are concerned, it cannot be doubted that systematic collecting will be sure to yield a certain number of new forms. With regard to the larger mammals, the case is, however, different, and it would be unwise to expect that any strikingly new type is likely to turn up, although important information will doubtless be obtained in due course with regard to the mode of life and the nature of the habitat of several of the mammals already known to us. The reasons for taking this somewhat discouraging view as to the prospects of discovering new animals of large size in Tibet are as follows:—

In the first place, although few Europeans have hitherto actually reached Lhasa, the country has been traversed to the northwards of that city from east to west—notably, by Messrs. Bower and Thorold in 1892—by travellers who have done all in their power to collect specimens of the fauna; while many sportsmen, naturalists, and collectors have penetrated far into the interior from either the eastern or the western border. Moreover, the typical Tibetan fauna inhabiting the high plateaus above 14,000 feet is closely allied to, if not absolutely identical with that of Eastern Ladak, which lies within the limits of Kashmir territory, and has therefore for many years past been readily accessible to Europeans. On the other hand, the mammals of the somewhat lower and apparently more or less wooded districts forming the eastern portion of Tibet range into the north-western provinces of China, such as Shansi and Kansu, where they have of late years been collected by Mr. F. W. Styan, an English tea-planter. Not that our information with regard to the mammals of Eastern Tibet depends by any means solely on the collections made in Kansu and Shansi. On the contrary, the great French missionary explorer, Abbé

David, succeeded many years ago in penetrating into the heart of the Moupin district of Eastern Tibet, whence he brought back a number of mammals belonging to types previously unknown to science. Practically all that has resulted from subsequent exploration and collection is to prove the extension of the range of these peculiar types into Western China, and to add to them a few species differing only in comparatively trivial features. The absence of any distinctly new types in this West Chinese fauna seems to point to the improbability of any striking novelty among the larger types of animal life remaining to be discovered in Tibet.

Of the strange animals first brought from Eastern Tibet by Abbé David, and subsequently obtained by Mr. Styan in Western China, by far the most remarkable is

Fig. 1.—Great Panda.

the creature now known to naturalists as the great panda (*Æluropus melanoleucus*), although at one time denominated the parti-coloured bear (fig. 1). In appearance this animal is, indeed, strangely bear-like, although far inferior in bodily size to most members of the *Ursidæ*; the rudimentary tail, plantigrade feet, short ears, and broad head being all ursine features. Moreover, it is not a little remarkable that a species of true bear (*Ursus pruinosus*) inhabiting Tibet not infrequently presents a type of coloration approximating to that of the great panda, in which the legs and under-parts, together with a band across the shoulders and a ring round each eye, are sooty black, while all the rest is pure white. On the other hand, when the face of the great panda is compared with that of the much smaller and long-tailed arboreal animal inhabiting the Eastern Himalaya, and known as the true panda (*Ælurus fulgens*), a marked resemblance can be detected, and when careful comparison between the teeth

Fig. 2.—Teeth of right side of jaw of Great Panda.

and skeletons of the two animals is made, it becomes apparent that the great panda is much more nearly related to the long-tailed species than it is to the bears. In fact, these two animals appear to be the Old World representatives of the raccoons and coatis of America, and thus afford one more instance of the close affinity existing between the faunas of Eastern Asia and North America. The teeth of the great panda (fig. 2) are most beautiful and interesting objects—on the whole approaching much nearer to those of the lesser panda than to the ursine type. Of the habits of the great panda, we are at present in complete ignorance; but on this point we may hope in time to be enlightened by the opening-up of Tibet. Whether we may ever expect to see such a wonderful creature alive in the Regent's Park, it is difficult even to guess. Probably the great panda is a native of the more or less wooded districts of Eastern Tibet, and not of the arid and elevated central plateau.

The same must undoubtedly be the case with the Tibetan snub-nosed monkey (*Rhinopithecus roxellanæ*) (fig. 3), which was likewise the first-known representative of a new generic type discovered in the Moupin district of Eastern Tibet by the Abbé David. It has, however, been subsequently obtained in Szechuan, while a second representative of the genus has been discovered in N.W. China and a third in the mountains bordering

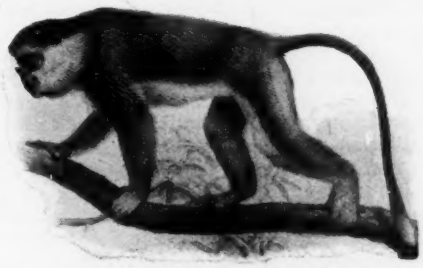

Fig 3.—Orange Snub-nosed Monkey.

the Mekong River. That the Tibetan representative of the snub-nosed monkeys, at all events, is a native of a cold climate may be inferred from its massive and "chubby" build and its thick coat, which in winter forms a long silky mantle of great beauty on the back. As to the peculiar form of the nose, so utterly unlike that of ordinary monkeys, the suspicion arises that it may be in some way connected with life at a high altitude, seeing that the Chiru antelope, to be noticed later on, has gone in for a very strange development in the way of noses. At present, however, we are very much in the dark as to the relative height of the districts in which these strange monkeys are found.

Nothing special need be said with regard to the above-mentioned Tibetan bear, except that it appears to be a peculiar species. The mere mention that the snow-leopard (*Felis uncia*) is an inhabitant of the Tibet plateau must likewise suffice, seeing that this handsome cat has a wide range in Central Asia.

Several species of deer are found in or near Tibet, although all of them appear to be confined to the wooded districts bordering the arid central plateau. The finest of these is undoubtedly the shou (*Cervus affinis*), a species allied to the red deer, inhabiting the forests somewhere near the head of the Chumbi Valley, in Sikhim. This deer is very rare in collections, where it is represented mainly by skulls and antlers, but it is probable that specimens will before long be forthcoming. A young individual is stated to have been killed during the early days of the Tibet expedition. Thorold's deer (*C. albirostris*) is a rather smaller and much darker coloured species, readily distinguished by its white muzzle and the comparatively simple antlers. It exhibits the relatively heavy build characteristic of species inhabiting cold countries. This fine deer was first obtained in the wooded districts to the north of Lhasa by the Russian explorer Przewalski, and subsequently by the English traveller Dr. Thorold, to whom the British Museum is indebted for its specimen. The third deer peculiar to the country is the Tibetan tufted deer (*Elaphodus cephalophus*), a species of the approximate size of a roebuck, and typifying a peculiar genus. In general character this deer is nearly related to the Indian and Malay muntjacs (*Cervulus*), the

bucks being armed with similar long tusks in the upper jaw, but the antlers are even smaller than in the latter, being reduced to mere knobs, and there are distinctive peculiarities in the skull. This interesting deer was first obtained by the Abbé David in the Moupin district of Eastern Tibet, but a second species was soon afterwards secured near Ningpo, in Eastern China, while a third kind has recently been described from the mountains near Ichang, in Central China.

In hollow-horned ruminants (oxen, sheep, antelopes, &c.) Tibet is specially rich, many of the species being peculiar to the country, where several of them are confined to the high central arid plateau. The first place in this group must undoubtedly be assigned to the yak (*Bos grunniens*), one of the finest and largest of the wild oxen, specially characterised by the great growth of long shaggy hair along the flanks and under-parts of the body and the well-known bushy tail. In this country, unfortunately, a somewhat false impression of the yak is prevalent, owing to the fact that all the specimens hitherto imported belong either to a small domesticated breed from Darjiling, or to half-breeds; the latter being generally black and white, instead of the uniform black distinctive of the pure-bred and wild animal. None of such half-breeds can compare with the magnificent half-tamed animals kept by the natives of the elevated Rupsu plateau, to the south of the Indus, where they afford the only means of transport by this route between Ladak and India. And even these Rupsu beasts are inferior to the wild yak, which stands nearly six feet at the shoulder. These magnificent animals are absolutely confined to the arid central plateau, on some parts of which, hitherto closed to Europeans, they are said to be comparatively numerous.

Another native of the same bare plateau is the Tibetan argali, or wild sheep *(Ovis ammon hodgsoni)*, a magnificent animal, with horns of wonderfully massive proportions in the old rams. Since, however, this species is only a local variety of the true argali of Central Asia generally, it is of less interest than the types exclusively confined to the country. The same may be said of the shapoo, or Tibetan urial *(Ovis vignei)*, which is the typical race of a smaller race of wild sheep, whose range extends in one direction into North-Western India and in another into Persia. A third species of wild sheep, the bharal, or blue sheep *(Ovis nahura)*, readily distinguished by its smooth and peculiarly curved horns and close grey-blue coat with black points, is, however, absolutely characteristic of the arid Tibetan plateau, on which it is found in large flocks. On the other hand, the Asiatic ibex *(Capra sibirica)*, which frequents the more craggy ground instead of the rolling uplands, is a species with a very wide distribution in Central Asia.

Although the yak and the bharal may be regarded as representing by themselves distinct subgeneric types, all the hollow-horned ruminants hitherto mentioned are members of widely-spread genera. We now come, however, to a remarkable species which is the sole representative of a genus quite apart from any other, and absolutely restricted to the arid central plateau. This is the graceful chiru, or Tibetan antelope *(Pantholops hodgsoni)*, of which the bucks are armed with long, slender, and heavily-ridged horns of an altogether peculiar type (fig. 4), while the does are hornless. Possibly this handsome antelope may be the original of the mythical unicorn, a solitary buck, when seen in profile, looking exactly as if it had but a single long straight horn. Although far from uncommon, chiru are very wary, and consequently difficult to approach. Like all Tibetan animals, they have a firm thick coat, formed in this instance of close woolly hair of a grey fawn colour. The most peculiar feature about the chiru is, however, its swollen, puffy nose, which is probably connected with breathing a highly rarified atmosphere. This antelope has never been exhibited alive in a menagerie, and, as is the case with the other large mammals of the central desert plateau of Tibet, it would probably not live if removed from its native uplands to ordinary levels. A second antelope inhabiting the same country as the chiru is the goa *(Gazella picticaudata)*, a member of the gazelle group characterised by the peculiar form of the horns of the bucks and certain features of coloration, whereby it is markedly distinguished from all its kindred save one or two other Central Asiatic species.

The most remarkable of all the Tibetan hollow-horned ruminants is, however, the takin (*Budorcas taxicolor*), of which the typical representative inhabits the Mishmi Hills, in the south-east corner of the country, immediately north of the Assam Valley, while a second variety is found further east, in the Moupin district. The takin, which may be compared in size to a Kerry cow, is a clumsily-built brute with yellowish-brown hair and curiously curved horns, which in some degree recall those of the South African white-tailed gnu. Its nearest relatives appear to be the serows of the outer Himalaya and the Malay countries, which are in many respects intermediate between goats and antelopes. As it lacks the thick woolly coat of the chiru and the goa, there can be little doubt that it inhabits a country with a less severe climate than that of the Central Tibetan plateau, and it is probably a native of the more or less wooded districts of comparatively low elevation forming the outskirts of Tibet. It is one of the few large animals that hitherto appears never to have fallen to the rifle of a European.

Fig. 4.—Head of Male Chiru.

With the large and handsome wild ass or wild horse (for it is, to a great extent, intermediate between the two), locally known as the kiang, we return once more to a characteristic denizen of the desert plateau forming the heart of Tibet. The kiang (*Equus hemionus kiang*) stands

close on 13 hands at the shoulder, and is of a bright red bay in colour, with the muzzle, under-parts, and legs dazzling white. Its ears (Fig. 5) are relatively much shorter and its hoofs much broader than in the true wild asses of Africa, from which it also differs markedly in colour, while its cry is somewhat between a bray and a neigh. In the higher and more open parts of Ladak, kiang are to be seen in large numbers; and they come galloping round the convoy of the traveller in circles, with their heads carried high in the air, so that the face is almost horizontal. Whether the kiang is entitled to be ranked as a distinct species, or whether it should be regarded merely as a variety of the chigetai or wild ass of Mongolia and the lowlands of Central Asia generally, is a moot point; but, be this as it may, the creature is absolutely confined to the central desert plateau of Tibet, where in winter it develops a coat as thick and rough as a door-mat, in order to afford effectual protection against the rigours of that season at such an altitude.

Fig. 5.– Head of Kiang.

In addition to the foregoing list of large mammals, Tibet is likewise the home of a number of peculiar species of smaller size. Among these it must, however, suffice to make mention of only two on the present occasion. Firstly, there is a remarkable species of water-shrew, differing in many respects from the common water-shrew (*Neomys fodiens*), and accordingly referred to a genus by itself under the name of *Nectogale elegans*. Of that genus it is the sole known representative. When we are fully acquainted with it, the Tibetan palm-civet (*Paradoxurus laniger*), at present known only by a single skin obtained so long ago as 1836, will prove almost as interesting a species, for it is quite probable that it will turn out to be generically distinct from the palm-civets of India and the Malay countries, from which it differs by its woolly coat.

Such a large number of peculiar generic and specific types of mammals restricted to a continental area of the comparatively small size of the Tibetan plateau is a feature unparalleled elsewhere, and to find an analogous instance we must take the case of an island like Celebes, which has been isolated for ages from all surrounding lands. It would seem, therefore, that Tibet has been similarly isolated, so far as immigration and emigration of its animal fauna is concerned, for a vast period of time; an insulation due, doubtless, to its great elevation above the sea-level, and the consequent severity of its climate and rarity of its atmosphere. Climatic peculiarities of this nature can only be endured by animals specially adapted to such conditions of existence; and it is accordingly only natural to expect that when once the Tibetan fauna had become modified for the needs of its environment it would have remained permanently isolated from that of the surrounding countries.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Artificial Illumination.—It seems not unlikely that all our present methods of artificial illumination will be regarded as elementary and crude in the not very distant future. We aim at getting enough light, but are not at all particular as to its quality. When the colour of an artificial light is modified, it is generally with the idea of making the lamp more ornamental, rather than for the sake of the light itself, for shades and globes are made of all varieties of tint. The result is that coloured objects appear different according to whether they are viewed by daylight or lamplight, the variation extending even to the character of the lamplight. For a long time we were contented with analogous photographic discrepancies, using only plates that render bright yellow and red as if they were dark grey or black, and some dark blues as if they were white, but we are now becoming alive to the importance of such errors. I have a piece of plaid material that has broad stripes of a light brick red, and a dark blue, which if photographed on an ordinary or even an isochromatic plate, shows no trace of the pattern. A photographic falsification of this kind would not be tolerated, but such a change as I noticed a little while ago, when a blue silk dress appeared to be a rich brown by the artificial light provided, would probably either pass unobserved or be regarded as a curious and unavoidable incident. It may be argued that daylight changes, and so indeed it does. Reds are hardly distinguishable from black, and blues and greens become grey as the night approaches, and twilight is the more beautiful because of it. But to bring the changes that are associated with the dying day into the full glare of a brilliant illumination ought to offend our good taste. A step forward in artificial illumination has recently been made by Messrs. W. M. Gardner and A. Dufton in the construction of a lamp for colour matching. They employ an arc light, and by means of suitable media absorb that part of the light that is excessive, and so obtain an illumination which they state "is precisely of the same character as that of good daylight from a north sky, and has the advantage over ordinary daylight of being perfectly uniform and unchangeable." Although intended only for matching colours, the same principle might be applied to ordinary illumination, and this offers a far greater and more important field for such modifications of artificial lights.

The Variability of Daylight.—The changeable character of daylight has a very large influence on photographic work, and therefore must be studied by those who would get better results than are obtained by the careless snap-shotter. As the sun gets low the daylight gets markedly more yellow, and we have from time to time been instructed that the excessive blue sensitiveness of gelatino-bromide plates becomes so far negatived on account of this change that it is not necessary to obviate it by the use of a yellow or orange-coloured screen. Whether or not this is so depends on what the photographer wants If he seeks to photograph an evening effect as if it were lit by such light as is given by the sun only when he is high up in the heavens, while the general effect is such as can be obtained only when he approaches the horizon, then he may omit the coloured screen. But if his aim is to photograph the scene before him as it is, there is as

much need for the yellow screen at sunset as at midday. The changes in light obviously affect all coloured objects. If a photograph in natural colours is made so successfully that it is an exact reproduction of the original as seen by full daylight, it may be different from the original when they are compared by evening light, because the colours of the photograph are only imitations of those of the object, and they may, and probably will, be differently affected by the change in the character of the light. If anyone desires a good illustration of the effect on colours of daylight of different kinds, he has only to get one of the separating black papers from a "premo-film-pack" as supplied by the Kodak Company, and see how the red printing on it appears by ordinary daylight and again by twilight. He may find in the latter case that the inscription has apparently vanished, or, if he can see traces of it, he will probably be unable to decipher it. If the red constituent of the light has gone, a pure red will appear black and be indistinguishable from it.

These changes in the light that reaches us from the sun are generally ascribed to the terrestrial atmosphere, particularly the aqueous vapour in it, and the fact that the light from the sun has to pass through more and more of the atmosphere as it sinks lower and lower. But the sun also has an atmosphere, and it is possible that variations in this may contribute to the changes that we observe. Professor Langley, who has worked at this subject for about thirty years, especially by means of his bolometer, has recently stated that there is "an increasing probability that the solar radiation itself varies in a degree appreciable to our present means of daily observation, and a strengthening of the belief that it probably varied through much greater ranges in the past, and may do so again in the future."

The Keeping of Sensitive Plates.—The time that sensitive material can be relied upon to maintain its good qualities is of great practical interest. Plates in England, if stored so that they shall be reasonably free from foul air, will last a long time in good condition if the emulsion is not very rapid. I recently had occasion to use some "spectrum" plates that are six years old, and found that they had a full red and green sensitiveness, that they worked clean, and, generally, were in good condition. They are rather slow, for the most rapid spectrum plates are six or eight times as fast. Slow plates of all kinds, if well made, will keep in good condition for an astonishing length of time. Ordinary fast isochromatic plates I have found when a year or so old to require about double the exposure they did when new, but otherwise satisfactory. The ultra rapid plates, whether colour sensitised or not, should be used as soon as possible after purchase. I have found such plates when a few months old to be only half as fast as at first, and to show considerable fog. It is obvious that a higher degree of sensitiveness must mean a want of stability, for sensitiveness and stability are directly opposed to each other. While, therefore, it is the makers' aim to provide plates that will keep well under all ordinary conditions, the user of them should bear in mind that high sensitiveness in plates means that they are affected by very feeble forces, and as it is impossible to keep them isolated from adverse influences whatever care is taken in their preservation, the more sensitive a plate, other things being equal, the shorter its life.

THE Thornton-Pickard Co. has sent us a prospectus of their Annual Competition, open to users of their apparatus. The prizes this year consist of twenty equal amounts of £5 in cash. The Competition closes on October 1, and full particulars and entry forms may be had free on application to them at Altrincham.

NOTES.

ASTRONOMICAL.

The Ninth Satellite of Saturn.

IT will be remembered that five years ago Prof. W. H. Pickering announced the discovery of a new and faint satellite of Saturn with a period of about a year and a half. The satellite, to which he gave the name of Phœbe, was discovered upon photographs taken with the 24-inch Bruce telescope. Eleven photographs, taken by Mr. Frost at the Arequipa Observatory, under the direction of Prof. Bailey, have enabled Prof. Pickering to follow the satellite from April 16 to June 9 of the present year, and to correct its ephemeris; and a full discussion of its orbit will appear in a few weeks, in a forthcoming volume of the Annals of the Harvard College Observatory.

* * *

Comet 1903 (Borrelly) and Light-Pressure.

In a paper in the "Astrophysical Journal" for July, Mr. S. A. Mitchell deals with the question of the formation of cometary tails by the influence of light-pressure. The researches of Bredichin had shown comets' tails to be of three different types according to the intensity of the repulsive forces which Bredichin explained as electrical in nature. This Lebedew showed not to have a sound physical basis, but Arrhenius has recently substituted the pressure of light. For a little cube of water with an edge of one micron, the pressure of the sun's light on it, at the sun's surface, is exactly equal to its weight; for a smaller cube the pressure would he greater than the weight, and hence the particle would be repelled. Measures of the angles between the tails of Comet Borrelly and its radius vector, made by Mr. Sebastian Albrecht on thirty-two photographs taken between June 22 and August 18, 1903, gave somewhat discordant results for the principal tail, but the mean of the best values gives the repulsive force as 18·47 times gravity. The values for the secondary tail agreed much better, and their mean was 1·824; the last four values gave a mean of 1·460, seeming to show the existence of a third tail, and this appeared to be corroborated from the photographs of August 12 and 15. The size of the particles forming the tails would be respectively 0·1, 1, and 1·33 microns. Mr. Mitchell concludes that there seemed to be a lagging even behind the direction given by the repulsive force; in other words, that the value of the repulsive force may increase as the comet approaches the sun. This increase, he considers, is in part at least real, and due to the more violent action of the gases liberated as the comet approaches the sun.

* * *

The Position of the Galactic Plane.

A most important and lucid paper by Professor Simon Newcomb has been published on the position of the galactic and other principal planes toward which the stars tend to crowd. He states the problem thus: "It is well known that the sky appears to us poorest in stars in the regions around the poles of the galaxy, and that it continually grows richer at a rate which is slow at first but more rapid afterwards, from the poles toward the galactic circle." Within the galactic girdle, the thickness of the stars in space is approximately constant, but in the Milky Way itself it is obvious that it consists of agglomerations of stars which have often fairly well defined boundaries; the stars here are much thicker than outside the girdle. The chief object of this paper is to determine this principal galactic plane, and also to determine whether the non-galactic stars condense towards this same plane or towards

other planes. Professor Newcomb makes no hypothesis as to the actual thickness of stars in space, but considers only their apparent distribution in the sky; and the problem is thus stated for mathematical discussion: "Let us suppose a plane taken at pleasure passing through our position in the universe, which point we take as the origin of co-ordinates. This plane will cut the celestial sphere in a great circle. The perpendicular distance of a star from the plane will then be represented by the sine of its distance from the great circle. Let us form the sum of the squares of these sines for the whole system of stars which we consider. The value of this sum will vary with the position which we assign to the plane. The principal plane of condensation, as I define it, is that for which the sum in question is a minimum." The working out of these expressions of condition gives a cubic equation whose three roots are the three principal planes of the system of stars; the smallest root corresponding to the plane of condensation, and the other planes being at right angles to it. If the system of stars should lie on a great circle then the value of the smallest root, corresponding to the plane of condensation, will be zero. In considering the galaxy a difficulty came up with regard to the great bifurcation between Cygnus and Aquila, and Professor Newcomb therefore considers two cases, one including the branch in the galactic system, and one omitting it. In neither of the two cases does he find that the central plane of the galaxy is accurately a great circle in the sphere; in other words the solar system does not lie quite centrally within the band of the Milky Way. Next Professor Newcomb considers "The Belt," or band of bright stars which first Sir John Herschel and later Gould showed as lying on a great circle which cut the plane of the galaxy at an angle of about 20°. Professor Newcomb shows indeed that this angle of deviation from the plane of the galaxy is only about 11°., from the consideration of 36 of these bright stars which do not exhibit large proper motion. Thirdly, he considers the plane of all stars to mag. 2·5; of all stars to mag. 3·5; of all the lucid stars; and finally for the Wolf-Rayet or Fifth Type stars. The following table gives the positions of the poles of these planes:—

	R.A.	Dec.
Galactic plane (omitting branch)	192°·8	+ 27°·2
Galactic plane (including branch)	191°·1	26°·8
Gould's Belt, as found by Gould	171°·2	30°·0
The Belt, from 36 stars of small p.m.	179°·6	26°·4
Plane of all stars to mag. 2·5	181°·2	17°·4
Plane of all stars to mag. 3·5	180°·0	21°·5
Plane of all lucid stars	180°·0	21°·5
Plane of the fifth type stars	190°·9	26°·7

From a consideration of the richness of the galactic region, Professor Newcomb concludes that if the galactic agglomerations were excluded from consideration, the crowding of the lucid stars towards their principal plane would be scarcely, if at all, greater than what we might expect as the result of the irregularity of chance distribution, and that we should still find a continuous increase in the richness of the sky from the poles to the galactic circle, where it would probably be nearly twice as great as at the poles.

BOTANICAL.

THOUGH the ovary of the oak (*Quercus*) is usually more or less perfectly three-celled, and each cell contains two ovules, the mature fruit, known to everybody as the acorn, nearly always contains only one seed, and therefore produces only one seedling. Professor Coker, in the January number of the *Botanical Gazette*, refers to acorns which invariably contain two or three seeds, and one is illustrated giving rise to three vigorous seedlings. These acorns were produced by a rock chestnut oak (*Quercus prinus*), found near Baltimore, Maryland. The same writer has met with a two-seeded acorn of *Q. velutina*, but in this instance the other acorns of the same tree were one-seeded.

Professor Coker also has an interesting note in the same publication on "Spore Distribution in Liverworts." He alludes to the fact that terrestrial species usually have their capsules raised on elongated stalks, while in the case of those that grow on trees the stalk of the capsule is seldom long, as in the latter the position of the plants some distance above the ground ensures the distribution of the spores on the dehiscence of the capsules. He shows, however, that in *Porella platyphylla*, though the vegetative shoots are closely adpressed to the bark of the tree, the fertile ones, just before the ripening of the spores, bend away from it and often project a centimetre or more. In consequence of this the spores get more exposure to winds, which prevent their falling and remaining amongst the leaves of the parent plant.

In recent volumes of the *Comptes Rendus*, Monsieur G. Bonnier has some interesting and important papers giving the methods and results of his cultural experiments on plants in the Mediterranean region, with a view to the modifications of their anatomical structure. The experiments have been carried on at Toulon, and at Fontainebleau, thirty-seven miles S.S.E. of Paris. Fifty perennial species were selected, each of which was split into two portions, one for cultivation at Toulon, the other at Fontainebleau. The plants were procured from the latter place, and the soil in which both sets were cultivated from Toulon. The results obtained are very interesting. Toulon has a less uniform climate than Fontainebleau, and is drier in summer, conditions which would be expected to lead to some modifications of the internal structure of the stems and leaves. The plants grown at Toulon have acquired the same peculiarities of anatomical structure as those of the plants of the same species found growing wild in that locality. The annual ring of wood was thicker and contained vessels of a larger calibre, while the leaf characters were more xerophytic than in the Fontainebleau specimens. Instances of remarkable variations in size and habit of plants grown in different latitudes and at different elevations are familiar to most botanists, and an extensive knowledge of such variations is most important to the systematist, who is often perplexed in determining whether characters with which he has to deal are of specific value, or whether they merely represent the influence of local conditions.

ORNITHOLOGICAL.

BY W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Infanticide by a Meadow-Pipit.

LORD BALFOUR OF BURLEIGH, in a letter to the *Field* for July 16, describes, on the authority of his keeper, how a meadow-pipit ejected its own young from the nest in favour of a young cuckoo.

The foundling, it appears, emerged from the shell some forty-eight hours after the first of the young pipits, but a few hours later the pipit was found outside the nest. Knowing nothing of the evil reputation of young cuckoos he replaced the nestling and watched for the hatching of the remaining eggs. This took place a few hours later, and he then saw what he believed to be the hen bird "remove first one and then the other and deposit her own offspring outside her home. Not being yet satisfied, he put two of the young ones back into the nest, and to avoid possibility of mistake watched operations a second time. He again saw the unnatural mother eject her own young in favour of the stranger. The young cuckoo was fed and tended by both titlarks and a few days after left the nest."

This account is certainly of extreme interest and is probably unique. There can be no doubt about the fact that normally the young cuckoo performs the work of eviction. Indeed, according to most observers, this little monster is specially endowed by Nature with a hollow back into which the victims are forced by the wings and held there till the edge of the nest is reached, when they are toppled over. Concerning this hollow back we shall have something to say later.

This letter was followed by another (July 23) from a correspondent who, after reading Lord Balfour's letter and finding dead wagtails outside the nest, came to the conclusion that

this eviction must have been the work of the parent wagtails, owing to the tender age and and helplessness of the cuckoo. But this is purely supposition.

* * *

Cuckoo Watching over its Young.

The cuckoo would appear to be a much maligned bird, or at least to be credited with fewer virtues than it really possesses. In the *Field* of August 6 a writer describes how a young and full-fledged cuckoo was seen on a lawn making "a noise more like squeaking than chirping," whilst overhead two old cuckoos were hovering. On three consecutive days the same thing was observed. In this account, however, there is no mention of their tender solicitude taking a more practical shape, since neither of the old birds appear to have fed their putative offspring. Since the cuckoo is well known to be a polygamist, he is probably at most only mildly interested in any of his numerous offspring which must be scattered over the area of his sojourn during his short stay in this country.

* * *

Sexual Differences in the Wing of the Lapwing.

Hitherto the sexes of the lapwing (*Vanellus cristatus*) have been regarded by ornithologists as almost indistinguishable. In the *Field* (July 16), Mr. F. W. Frohawk shows conclusively that a very ready distinction may be drawn between the sexes at all ages, inasmuch as in the male the primaries from the 3rd to the 10th are both broader and longer than in the female; so much so that in the outstretched wing the primaries of the male form a broad round fan projecting conspicuously beyond the line of the free edge of the secondaries. Further, in the male the secondaries grow shorter from without inwards so as to impart a sinuous line to the free edge of this region of the wing. It is strange that in so familiar a bird this difference should so long have remained undetected. As Mr. Frohawk points out, it is probably this great fan-shaped expansion of the wing which makes the remarkable flight of the lapwing at the breeding season possible.

* * *

Decrease in Weight of Incubating Eggs.

Mr. H. S. Gladstone, in the last number of the *Ibis*, contributes an extremely interesting note wherein he shows, by a series of careful weighings, that eggs lose in weight during incubation. Experimenting with pheasants' eggs he shows, in a table of averages, that between the first day and the twenty-third the loss is as much as 2 drs. 12 grs. Weighed every fourth day the loss on the average varies between 9 and 10 grs. The history of any single egg is sometimes very striking; thus an egg which, just laid, weighed 17 drs. 19 grs. at the twenty-third day only turned the scale at 13 drs. 10 grs.

* * *

Blue-throat near London.

Mr. E. Chubb, in the *Zoologist* for July, records the occurrence of the Blue-throat (*Cyanecula suecia*) at Sheen Common on June 17. There can be no doubt about the identification in this case, for he remarks: "What struck me first was the beautiful band of light blue round the throat. . . . as it settled on a fence within a few yards of where I stood." Though he could not make out the colour of the spot in the throat, Mr. Chubb inclines to the belief that this bird was of the red-spotted species, and in this we agree. The white spot would have been conspicuous; moreover it is a much rarer visitor.

* * *

Long-eared Owl Nesting on the Ground.

Since the long-eared owl (*Asio otus*) very rarely nests on the ground it is interesting to note that a further instance has occurred at Witton Park, near Blackburn. A description of the nest, together with an excellent picture of the female and young, appears in the *Zoologist* for July.

ZOOLOGICAL.

Gibbons in Sumatra.

ACCORDING to Dr. W. Volz, who has recently been travelling in the country, the two banks of the Lematang River in the Palembang district of Sumatra are respectively inhabited by different species of long-armed apes, or gibbons. On the west bank is found the siamang (*Hylobates syndactylus*), while the country to the east of the river is the home of the agile gibbon, or wau-wau (*H. agilis*). It is not necessary to capture, or even to see, specimens of the two species in order to satisfy oneself as to their limitations, for they may be readily distinguished by their cries, the siamang calling in a single note. whereas the cry of the wau-wau forms two notes. The remarkable thing about their distribution in Palembang is that the two species are found in company throughout the rest of Sumatra; and even in Palembang itself they inhabit the mountain districts, where the river is so narrow that they could easily leap over it, and yet they keep to the opposite banks.

* * *

Papers Read.

At the meeting of the Entomological Society of London held on June 1, Colonel Sainhoe read a paper on Tropical African moths of the family *Geometridæ*; Mr. W. L. Distant contributed some notes on additions to our knowledge of the cicalas (*Cicadidæ*); the President communicated an article by Mr. G. F. Leigh on series of butterflies of the species *Papilio cenea* and *Hypolimnas misippus*; while Mr. E. Saunders described collections of Hymenoptera from Majorca and Spain.

* * *

Wild Asses and the Quagga.

The August issue of the *Proceedings* of the Zoological Society of London contains two coloured plates of Asiatic wild asses now living in the Duke of Bedford's park at Woburn. The two species portrayed are the kiang, or wild ass of Tibet, and the chigetai, or wild ass of Mongolia. The description of the two animals is by Mr. Lydekker, who, we understand, has written a paper on wild asses generally, which will shortly be published in *Novitates Zoologicæ*, the official journal of Mr. Rothschild's splendid private museum at Tring. To the journal first mentioned Mr. Lydekker also contributes some notes on the extinct quagga, in which he confirms the alleged existence in the skull of that species of a vestige of the cavity for the face-gland which was fully developed in the ancestral three-toed hipparion. He also refers to the recent gift to the British Museum of a portion of the head-skin of a quagga shot in the forties, which had been made into a sheath for a hunting-knife.

* * *

The Lily-Cradled Bat.

A gorgeously coloured Oriental bat (*Cerivoula picta*), whose wings are brilliant orange and black, has been generally supposed to owe this coloration to a protective resemblance to the decaying leaves and ripe fruit of the plantain, among which it commonly dwells. A correspondent of Captain Stanley Flower has, however, stated in one district of Siam this bat reposes in the flower of the Cala lily. The colour of this lily is not stated, but it may be presumed that it is somewhat similar to that of the bat. In commenting on the statement, Dr. Jentink, of Leyden, remarks that "it sounds like a wonderful tale, a golden red and black coloured bat sleeping in a lily-flower!" Can it be that the plaintain bat has a double colour-adaptation—to the plantain in India and to the Cala lily in Siam?

* * *

Alleged Cannibalism in Snakes.

In a recent issue of the *Journal* of the Bombay Natural History Society numerous instances are cited of snakes devouring one another; this kind of diet being stigmatised as "cannibalism." Seeing, however, that in all the instances cited in this particular communication the devourer was of a different species to the one devoured, this is surely a misnomer. We might as well say that it is cannibalism on the part of a great grey shrike to kill and eat a sparrow, or of a rat to devour a field-mouse. When, as happened some years ago in the Zoological Society's Menagerie

a python devours one of its own kind, we have an undoubted case of cannibalism; but it is highly improbable that acts of this description ever take place in a state of nature.

* * *

Black Leopards.

Many people persist in believing that the black leopard is a distinct species. An additional piece of evidence that this is not the case is afforded by a correspondent of the *Indian Field* newspaper, who writes that in the Bhamo district of Upper Burma he recently found a pair of leopard-cubs, one of which was black and the other of the ordinary spotted type. The tendency to blackness, or melanism, it may be noted, is most marked in hot, moist climates, like that of the district in question.

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The World's Consumption of Ivory.

Our contemporary the *Zoologist* for May last contained a very interesting article on the supply of ivory from the Congo Free State, and of the world's annual consumption of this commodity. As regards the latter item, it appears that the total reaches the enormous figure, on an average, of 647,000 kilos., of which India and China take 144,000 kilos., the rest going to European markets. As regards the price of ivory, it may be mentioned that average tusks fetch from 24 to 25 francs per kilo., while the round and full tusks of from 6 to 8 centimetres in diameter realize as much as 30 francs per kilo. On the other hand, the price of inferior descriptions is only from 13 to 15 francs per kilo. A kilo, we may add, is equal to 2·204 lbs., that is to say practically $2\frac{1}{5}$ lbs.

* * *

The Classification of Reptiles.

The relationships of the different orders of living and extinct reptiles and the best mode of illustrating these in systematic classification are discussed by Mr. G. A. Boulenger, of the British (Natural History) Museum, in the August issue of the Zoological Society's *Proceedings*, at the end of a paper on the skeleton of a curious little reptile from the New Red Sandstone of Elgin. It has of late years become more and more evident that the remarkable extinct anomodonts of the equivalent of the New Red Sandstone in Africa and elsewhere differ very widely from all other reptiles, and approach mammals, of which they were undoubtedly the ancestors. For the first time this has been fully and definitely recognized in classification by Mr. Boulenger, who now divides reptiles into two brigades, the one including the anomodonts and their immediate relatives, and the other all the rest. The former brigade is termed Reptilia Theromora (= Theromorpha), or Mammal-like Reptiles, and the latter (from which birds took their origin) Reptilia Herpetomorpha, or Reptile-like Reptiles. In view of the fact that the latter combination is nothing less than tautology, the substitution of Reptilia Ornithomorpha (Bird-like Reptiles) may be suggested; and the two brigades would then be respectively known as the Theromorpha and the Ornithomorpha. There can be no doubt that Mr. Boulenger's classification is much superior to the one recently proposed by Professor H. F. Osborn, of New Haven, U.S.A.

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Corrigendum.

In the article on the Later History of the Horse in our August issue cuts 2 and 3 are unfortunately transposed.

CORRESPONDENCE.

Salmon in Fresh Water.

DR. THOMAS P. TUCKEY writes:—That salmon never feed in fresh water I cannot credit, notwithstanding all the evidence adduced to the contrary. That no food has ever been found in the stomach of a salmon caught in fresh water I can well believe. I have the evidence of a man who fished the Blackwater in the South of Ireland ever since he could fish. This man died only a couple of years ago. He was a grown man before I was born, and I am a grandfather. This old man told me only the year before he died that he had never found anything in a salmon's stomach. Nay, he told me of a salmon which he once gaffed, supposing it to have been a fish which had broken away from some angler and which had been caught by the attached piece of line in a snag. To his astonishment, he found that the fish was stone-blind, and had only rudimentary eyes; it was, however, plump, and had all the appearance of a newly-run fish. But I have instituted inquiries among the fishermen who take salmon in nets at the mouth of Fowey Harbour, and also among those who catch them in the tidal part of that river, and they have assured my informer that, though in the habit of repeatedly cleaning salmon after their capture, they have never found any food in such salmon. Now, it is quite incredible that salmon never feed either in the sea or during their sojourn in rivers, and it is much more probable that the same causes operate on the salmon in both their salt and fresh water habitats. We know how greedily they rise at the artificial fly, an object, to be sure, like nothing on earth or in the water, but still the salmon must liken this bait to some natural object, or they would not be so frequently caught by means of it. A salmon's sole idea of a salmon fly must be that it is something eatable, otherwise it would not open its mouth to get caught by the hook. But whatever objection may be brought forward about the artificial fly, what can one say about the worm, the minnow, and the shrimp? The worm the salmon has often seen floating by; the minnow and the shrimp swimming about in dozens, is it to be supposed that the fish will only take one or the other of the latter when they have a piece of gut attached to them. Such reasoning is truly a *reductio ad absurdum!* I daresay that salmon find it hard to support themselves in rivers, but Mr. Aflalo, in his "Natural History of the British Islands," states that "Salmon-roe is a deadly and illegal bait for the fish themselves." Salmon-roe is, I know, a deadly bait for trout. I have not heard of its being used for salmon, but I am sure, if we are to judge by the rest of his work, that he knows what he is writing about.

The true solution of the matter, I think, will be found, when we know exactly what the salmon's usual food is. I should guess that in the sea it consists of jellyfish or some such soft gelatinous food, that its digestion is very rapid, and the undigested residue very trifling; and that in rivers the ova of fish may make one of its principal meals. I have also thought that the iridescent colours of the artificial fly may, to the salmon, similate the appearance of jellyfish, some of which when floating in the water display all manner of delicate and beautiful colours. This, of course, is mere conjecture, but I cannot fancy that a salmon swallows a mixture of gold twist and jay feathers for the fun of the thing, any more than I can believe the old fox-hunter when he asserted that Reynard liked being hunted.

REVIEWS OF BOOKS.

We have received from Messrs. Newton and Co., of Fleet Street, their new X-Ray catalogue, which includes information of a comprehensive kind regarding the "Apps-Newton" induction coils, the mercury breaks of improved patterns, and other apparatus for both experimental and practical work. Messrs. Newton announce the installation on their premises of an extremely useful switchboard equipment, by means of which customers can make themselves familiar with its use, and with the proper manipulation of their instruments.

The Northampton Institute and Technical Optics.—In connection with the extremely useful classes in Technical Optics which have been developed at the Northampton Institute by Dr. Mullineux Walmsley, and which have received the warm support of the optical trade, a scholarship has been instituted by Messrs. Aitchison, to be called the "Aitchison Scholarship," which will defray the cost of the course of instruction of the student who wins it in the Institute's Day Courses of Technical Optics for two years, and will leave him a small balance in addition. The full course, as at present contemplated, extends over two years, and consists of lectures, laboratory work, drawing office work, tutorial classes, and workshop practice. Partial courses, extending over three years, have been arranged for those already engaged in some optical trade, and the scheme must command the warmest support of all interested in British Technical and Optical industries.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Coccidae.

With Notes on Collecting and Preserving.

By ALICE L. EMBLETON, B.Sc.

As greenhouse and garden pests, "scale insects" and "mealy bugs" are only too well known to the florist and horticulturist, for they abound in most climates, particularly in the tropics. They are easily distinguished from other insects, being strikingly different in many ways. The brown "currant scale" (*Lecanium coryli*) will serve as an example; or the brown "peach scale" (*Lecanium persicum*), both very serious enemies to the fruit-grower in this country. The description applies almost as well to the dreaded vine pest (*P. vitis*), which plays much havoc in wine-producing countries, and equally truthfully to the common brown scale on ferns and palms grown indoors (*Lecanium hemisphaericum*). These insects, and many others, are very similar in appearance, and also agree in being of considerable economic importance. A sketch of the scale found on the bark of currant bushes will suffice to illustrate the general nature of these creatures. In the adult stages they are firmly fixed to the host plant, and appear as small brown convex elevations, about one-eighth to one-sixth of an inch in length; the convex dorsal shell still bears some trace of a keel-like ridge running from back to front, sending out transverse branches connecting this keel at right angles to the limiting circumference. This description is of the female, for the male is winged, is less common, and has but a short life, so it may be left out of the present description. To return to the adult female of *Lecanium coryli*, it is found that under this hard, shining brown carapace she lives and breeds. In the winter her enveloping shell fits close to the surface to which it is attached, and it needs care to remove the creature uninjured; but in July one finds that the rounded mother-shell is nothing but a tent covering a heap of substance that looks like pink dust, but which is, in reality, the mass of eggs of the coccid. In a short time these eggs give rise to small yellow six-legged larvæ, which move about restlessly all over the parent plant. It is interesting to note that the larvæ of most species seek to avoid light by creeping into crevices in the plant. At the end of about ten to fourteen days these active larvæ settle down, and become fixed to the host plant by means of the long thread-like proboscis which is then buried deeply into the vegetable tissues; the nourishing sap being drawn up by this apparatus. The creatures have now assumed the characteristically "scale" mode of life, the white waxy powder which has until now coated them disappears, and gradually the mature condition is reached, and the cycle begins once more.

In different species there are, of course, minor dissimilarities, but in these characteristic features many species are alike. Some species, such as the currant brown *Lecanium*, produce at least three broods of young in the year.

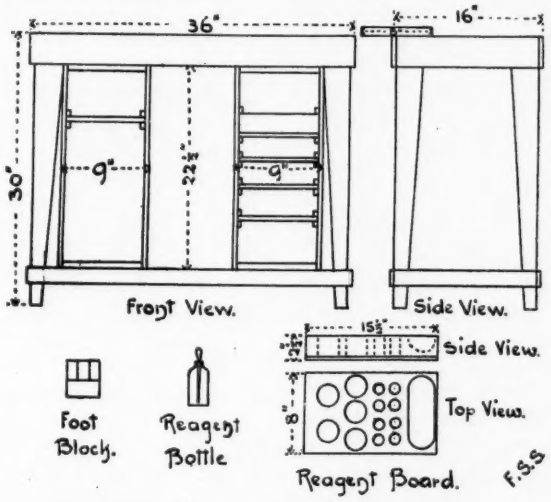
Dactylopius destructor or *D. longifilis* will serve as an example of mealy bugs. They are also easily recognised, for they possess such distinctive characteristics that there is no fear of ambiguity in identification; this is more particularly the case with *D. longifilis*, which is marked by the long white posterior filaments in the female. The most common species in our greenhouses is *D. destructor*. Though they are such common and destructive insects, yet there is very little literature to be found on the subjects either of their life-history and habits, or morphology. However, it is known that they are very prolific, the female of *D. destructor* laying usually from 400 to 600 eggs at a brood. They are embedded in a white flocculose network of waxy threads, which cover the eggs and quite effectually protect them from attacks of other insects. The female feeds all the time she is depositing her eggs, and the end finds her nothing more than a little dry piece of dead skin, with the mass of eggs behind her. Before egg-laying commences she measures about 4mm. in length. In two or three weeks the young hatch out of the eggs, and after a day or two they leave the protection of the white flocculent covering and begin to wander about actively. They possess at this stage very conspicuous antennæ and legs, and are of a pale yellow colour. In one such brood there may be a dozen males; these soon separate themselves from the rest to construct a special little fluffy cocoon, from which, after two or three days, the winged male emerges. It is provided with three pairs of eyes, and lives but a very short time. *D. longifilis* is not oviparous like *D. destructor*, but is viviparous. It is a larger creature, but not so prolific, though it is as general a feeder as the allied species. These pests are very abundant in hothouses, where the artificial conditions of relatively constant temperature, moisture, and food supply give them a specially favourable environment, and their rate of production is consequently very rapid.

America suffers even more from the ravages of *Coccidae* than we do in this country; perhaps its most destructive insect is the San José, or Pernicious scale (*Aspidiotus perniciosus*). It is so widely disseminated, and has become so firmly established in the principal deciduous fruit regions of the United States, that its extermination is now, in most cases, out of the question; it is looked upon as a permanent factor to be regularly dealt with. There are, of course, the preventive and quarantine measures against introducing it into new regions on nursery stock, but once it has a foothold the only certain method of destroying it is the heroic measure of digging up and burning all infested trees. But orchards can be made profitable even if the scale be there, by controlling its spread by means of insecticides. The San José scale is found in Japan, being apparently of recent origin; probably it came on American fruit trees, chiefly from California, where it has been longest established, and where its ravages are most serious. But it is interesting to note that in Japan the San José has met its match, in the person of the little twice-stabbed ladybird beetle (*Chilocorus similis*). This beneficent little creature is the enemy of Japan's destructive scale, *Diaspis pentagona*, and, fortunately, it has taken just as readily to the introduced species, and very materially checks its increase.

(*To be continued.*)

Microscopical Table.

A correspondent, writing over the initals J. Q. T. writes from Queensland Australia :—"At various times I have seen in your columns descriptions of work-tables for microscopy, and I venture, therefore, to send a description of how I made my own. The top of my table is made of half-inch pine, 36 inches by 16 inches, and is raised on four legs 30 inches from the ground. To make the table steady, I screwed on cross-pieces at both back and front, and at the sides, as illustrated. The lower front and back cross-pieces were 22½ inches from the upper cross-pieces, and upon these I screwed two narrow boxes 22½ inches in height, 16 inches deep, and 9 inches wide. To the front of these I attached doors by means of ½-inch hinges, and arranged a simple wire hook to fasten them, though a small lock or bolt would doubtless be preferable. The cupboards thus constructed contain as much as possible of my apparatus, excluding, of course, stock-bottles of reagents, etc., and are fitted with shelves in the following way. In the left-hand cupboard there is only one shelf for my objective jar (in this climate it is only safe to keep object-glasses in an air-tight jar with calcium



chloride), immersion oil, and purely optical accessories. In the space beneath I place the microscope itself in its case. In the right-hand cupboard the shelves are much more numerous, and are fitted so as to run in grooves. The upper shelf contains the reagents. For this I took a thick 2-inch board, pierced it with holes from one inch to three inches diameter, and then screwed it on top of a ½-inch board as shown in the sketch. At one end I gouged out a groove 8 inches long, 3 inches wide, and 1 inch deep to serve as a useful receptacle for section-lifters, brushes, etc., which should be conveniently at hand. It should be noted that the 2 inch holes in this shelf are the proper size to hold Grubler's 100 cc. reagent bottles, which I have found very useful. The bottles containing fixing, staining, clearing, etc., fluids are placed each in its proper hole, and on starting work the board is brought out and placed on the table. The shelf below is utilised to carry slips, cover-glasses, troughs for pond-life, etc. In the next shelf are kept note-books, pens and pencils, ink, paper, camera lucida, and other accessories for recording observations ; below this a turn-table, brushes, bottles of cement and varnish, etc., and so on. If work has to be left suddenly, a bell-jar is placed over the microscope to protect it from dust. To the front right-hand corner of the table is screwed a piece of 1 inch pine, 2 inches wide and 8 inches deep, so that 4 inches are on the table and 4 inches project ; to this is clamped a small microtome. When using the table as a support for a photo-micrographic camera it was found to vibrate unpleasantly, and this I obviated by the following simple device. Eight pieces of 2-inch wood, each 4 inches square, were taken, and in four of these holes were drilled to take the feet of the table-legs, and they were then screwed to the top of the other four pieces of wood with pieces of rubber between (I made use of some old rubber tyre-tubes). All the bottles except those containing mounting media are fitted with corks and rubber-capped pipettes. To give the table a finished appearance I stained it with the following mixture, which was recommended some years ago in the American 'Journal of Applied Microscopy' : (*a*) Copper sulphate, 25 parts ; potassium chlorate, 25 parts ; water, 200 parts. Dissolve the salts in hot water, apply hot, and give a second coat when the first is dry. Then apply (*b*) aniline oil, 12 parts ; hydrochloric acid, 18 parts ; water, 100 parts. This second solution must be applied cold. The power of the stain is much increased by subsequent washing with hot soap-suds and water. This stain gave a fine black, which is not affected even by nitric or sulphuric acid if they are quickly wiped off. My water supply consists of a large bottle (containing about 80 ozs.) placed on a shelf to the right of and above my table. From this comes a siphon of glass tube with rubber joints (rubber being perishable) ending in a fine jet a few inches above the table and closed by a clamp. The sink is a large enamelled bucket to receive waste liquids, and there is a tin box for waste paper, broken glass, etc."

Notes and Queries.

Reversal of Image in Using Beale's Camera Lucida.

A correspondent writes: "In making drawings of sections, when it is desired to sketch in the outlines by using the camera lucida and to put in the details freehand with direct vision, Beale's reflector, with its partial reversal of the image is notoriously awkward to work with, but its principal fault may be counteracted by the following procedure, so far as work with the lower powers is concerned. Put the slide upon the stage upside down, *i.e.*, with the cover-glass underneath, and focus through the thick glass slip, sketch the rough outlines, &c., of the section, then remove the reflector, reverse the slide so as to focus through the cover-glass as usual, and with a higher power if necessary, fill in the finer details freehand, using direct vision. Each part of the section will thus be found in its proper place in the outline sketch. Care must be taken not to knock the cover-glass sideways when removing it. If the stage aperture is small, the slip can be supported at the ends by pieces of glass." Another correspondent, Mr. C. H. Caffyn, suggests drawing on a sheet of paper placed on a piece of carbon or black-leaded paper, by which means the outlines will be found reversed when the paper is turned over, and can then be filled in without the use of the camera lucida.

[Communications and enquiries on Microscopical matters are invited, and should be addressed [to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.]

The Face of the Sky for September.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.14, and sets at 6.46; on the 30th he rises at 6.0, and sets at 5.39. The equation of time is zero on the 1st.

Autumn commences at noon on the 23rd, when the Sun enters the sign of Libra.

There is a total eclipse of the Sun on the 9th, invisible in Europe, the shadow path lying entirely over the Pacific Ocean.

Sunspots, faculæ, and prominences are fairly numerous; at the time of writing, three groups of spots, as well as a considerable amount of faculæ, are visible.

The positions of the spots, &c., with respect to the equator and poles may be derived by employing the following table :—

Date.	Axis inclined from N. point.	Centre of disc, N of Sun's equator.
Sept. 1 ..	21° 19′ E.	7° 13′
,, 11 ..	23° 33′	7° 14′
,, 21 ..	25° 12′	7° 2′
Oct. 1 ..	26° 11′ E.	6° 38′

THE MOON :—

Date.	Phases.	H. M.
Sept. 3 ..	☾ Last Quarter	2 59 a.m.
,, 9 ..	● New Moon	8 43 p.m.
,, 16 ..	☽ First Quarter	3 13 p.m.
,, 24 ..	○ Full Moon	5 50 p.m.
Sept. 9 ..	Perigee	7 12 p.m.
,, 23 ..	Apogee	6 0 a.m.

OCCULTATIONS. — The Moon passes through the Hyades about midnight of the 29th, when many of the stars are occulted; Aldebaran suffers occultation soon after sunrise on the morning of the 30th.

THE PLANETS.—Mercury is in inferior conjunction with the Sun on the 16th, after which date he is a morning star in Leo.

Venus sets too soon after the Sun to be suitable for observation.

Mars is a morning star on the confines of Cancer and Leo, rising about 2.25 a.m. on the 15th.

Jupiter is the most conspicuous object in the sky, looking nearly due E. about 9 p.m. On the 15th he rises at 7.15 p.m., and is on the meridian at 2.16 a.m. The equatorial diameter of the planet on the 14th is 48″·4, whilst the polar diameter is 3″·1 smaller.

The planet is near the Moon on the evening of the 26th.

The configurations of the satellites, as seen in an inverting telescope at 12.30 a.m., are as follows:—

Day.	West.	East.	Day.	West.	East.
1		43○21	16	4321○	
2		4231○	17	42○1	3●
3		4○$^{1}_{2}$3	18	41○23	
4		4○123	19	42⊙3	
5		21○43	20	42○13	
6		2○314	21	3$^{4}_{1}$○2	
7		31○24	22	3○4$^{2}_{1}$	
8		3○214	23	321○4	
9		$^{2}_{3}$1○4	24	2○14	3●
10	●2	○$^{1}_{3}$4	25	1○234	
11	●1	○234	26	⊙$_1$⊙$_2$ ○34	
12		21○43	27	2○134	
13		2○413	28	$^{3}_{1}$○24	
14		$^{4}_{3}$1○2	29	3○1$^{2}_{4}$	
15		43○$^{2}_{1}$	30	3214○	

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn is a very conspicuous object in the sky looking S. about 10 p.m.; he is on the meridian at 9.30 p.m. near the middle of the month, and although rather low down in the sky he well repays observation, for even with small instruments the planet is a beautiful object. The polar diameter of the ball is 17″·0, whilst the major and minor axes of the outer ring are 42″·5 and 11″·7 respectively; thus the ring plane is inclined to our line of vision at an angle of 16°, the northern surface being visible.

Uranus is on the meridian about 6 p.m. near the middle of the month, hence the best time for observation is immediately after sunset. He is practically stationary throughout the month, and is situated about 12 minutes W. of the star 4 Sagittarii.

Neptune does not rise until after midnight.

THE STARS :—

At the beginning of the month, at 9 p.m., the following constellations are to be observed :—

ZENITH . Lyra, Cygnus.

SOUTH . Aquila, Delphinus, Aquarius, Capricornus, Sagittarius; Serpens, Ophiuchus, and Scorpio to the S.W.

EAST . Andromeda, Pegasus, Pisces, and Aries; Pleiades on horizon.

WEST . Hercules, Corona, Boötes.

NORTH . Ursa Major, Ursa Minor; N.E., Cassiopeia and Perseus; Auriga (*Capella*) low down.

Minima of Algol occur on the 6th at 9.53 p.m., 9th at 6.42 p.m., 26th at 11.36 p.m., and 29th at 8.25 p.m.

TELESCOPIC OBJECTS :—

Double Stars :—ζ Ursæ Majoris XIII.^{h} 20^{m}, N. 55° 26′, mags. 2, 4; separation 14″·4.

ζ Aquarii XXII.^{h} 23^{m}, S. 0°·35′, mags. 4, 4, separation 3″·2. Both components are yellowish.

β Cygni XIX.^{h} 27^{m}, N. 27° 45′, mags. 3, 5; separation 34″. The brighter component is yellow, the other blue; very easy double in small telescopes with a power of 20.

Cluster (M 11) in Aquila or Antinous. R.A. 18^{h} 46^{m} Dec. S. 6° 23′. Very pretty object for 3 or 4 inch telescope; it is an easily resolvable fan-shaped cluster, with an 8th magnitude star in apex and an open pair of the same magnitude just outside it.

XUM